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LET US FULFILL THE OBLIGATIONS WE HAVE UNDERTAKEN

Translated from Metallurg, No. 3, pp. 1-2, March, 1960

Our Motherland is experiencing joyful days. Industry and agriculture are at a high level, the prosperity and cultural level of the Soviet people are steadfastly rising.

Metallurgists in the past year have attained remarkable achievements. Many collectives of metallurgical enterprises have completed, with honor, their obligations for fulfillment of the plan ahead of schedule for the first year of the Seven-year Plan. The initiators of competitions, the collective of the "Zaporozhstal'" plant, attained outstanding successes. The Zaporozh steelmakers I. Moiseenko, P. Zalozh, S. Shestakov, and N. Guban' achieved a record productivity, on the 185-ton furnace, having smelted 237 thousand tons of steel during the year, which exceeded the average plant productivity by ten thousand tons. However, the brigade collective did not rest on their laurels. The steelmakers have decided to exceed in 1960 their own record and achieve a productivity of 240 thousand tons in the year by a savings in time and by an increase in the removal of steel from a 1 m^2 furnace hearth.

Putting into practice the historical decisions of the Communist Party of the Soviet Union, the metallurgists have enlarged the struggle for fulfilling the plan of the second year of the Seven-year Plan ahead of schedule. The collectives of the shops, of the brigades, of the sections of metallurgical enterprises of the entire country are undertaking increased obligations.

The call of Comrade N. S. Khrushchev at the December Plenum of the Central Committee of the Communist Party of the Soviet Union to search for additional reserves of metal for a more complete assurance of the needs of the collective farms and the state farms found a fervent response in the metallurgists.

Petr Makhota, steelmaker, hero of Socialist Labor at the Petrovskii Plant came forward with patriotic zeal. The brigade which he leads has proposed to create a reserve of metal in excess of the plan and has pledged to give to this reserve not less than 500 tons of steel in 1960 by improved utilization of the furnace, by increasing its durability, and by shortening the smelting time.

The metallurgists of the Magnitogorsk Metallurgical Combine, the largest in the country, have responded to N. S. Khruschev's appeal with gladness. In the socialistic obligations which they have accepted is stated, "The working class has always rendered manifold assistance to the countryside. We will spare no pains and labor in order to help also the toilers of agriculture to solve successfully the majestic problems outlined by the December Plenum of the Central Committee of the Party."

On the initiative of the collective of the foremost open-hearth plant No. 2, socialist competition has developed in the shops of the Combine for fulfilling the 1960 plan ahead of schedule. The men of Magnitogorsk have pledged to give 100 thousand tons of ore, 100 thousand tons of agglomerate, 20 thousand tons of pig iron, 50 thousand tons of steel, and 25 thousand tons of rolled goods over the annual plan. In order to solve successfully these tasks, the collective of the Combine introduced numerous innovations which assure further technical progress in the main sector of the Combine. The workers of the Magnitogorsk Metallurgical Combine have pledged to save 15 million kw-hr of electrical power, to decrease the consumption of ferrous metals by 1%. It was decided to increase the output of shapes of rolled goods which facilitate savings. Ten million rubles will be saved by the careful expenditure of raw materials, fuel, materials, and electric power. The metallurgists have pledged to introduce 3400 suggestions from efficiency experts, the total savings from which will be 33 million rubles.

The decrees of the December Plenum of the Central Committee of the Communist Party of the Soviet Union aroused a fervent response from the metallurgists of one of the test plants in the South, the "Zaporozhstal' " Plant. The collective of this plant has pledged to increase in 1960 the production of pig iron by 18 thousand tons, of steel by 20 thousand tons, of steel sheets by 17 thousand tons. All of the metal in excess of the plan has been pledged by the workers at a savings in raw material, fuel, and electric power. The realization of the measures taken for mechanization and automation makes it possible to increase the productivity of labor by 9.7% as compared with 1959. The savings from the reduction in the cost of production will be 10 million rubles, and from the introduction of the suggestions of the efficiency experts not less than 20 million rubles.

News of the working enthusiasm of metallurgists arrives also from other plants in the country.

In answer to the call of Petr Makhota, the brigades of steelmakers of the Dzerzhinskii Plant led by V. Shkirko, V. Selivanov, and P. Tregub produce tens of tons of metal in excess of the plan daily. At the Zakavkazskii Metallurgical Plant, on the initiative of steelmaker Amiran Pantsulaya, leader of the brigade of Communist Labor,

competition has developed for the creation of a reserve of metal in excess of the plan for the needs of agriculture. Steelmakers Amiran Pantsulaya, Mikhail Spandarashvili, and Boris Ivantsov have pledged to give 1500 tons of steel each to this reserve.

The metallurgists of the Kuznets Metallurgical Combine have also actively responded to the call of Comrade N. S. Khrushchev to produce metal in excess of the plan for agricultural needs. Steelmakers, Hero of Socialistic Labor M. Burkatskii, A. Shabalov, M. Kuznetsov, and D. Kuznetsov have pledged to give, during 1960, not less than 4,000 tons of steel in excess of the plan. The steelworkers of the Combine have pledged to produce 33.5 thousand tons of steel over the plan, the blast-furnace operators have pledged to smelt 20 thousand tons of pig iron, the miners to produce 24 thousand tons of ore and to sinter 27 thousand tons of agglomerate.

The working enthusiasm of the metallurgists places serious tasks before the trade union organizations. Their duty is to assure the fulfillment of the increased obligations. The trade unions must mobilize the collectives of the shops, of the sections, of the brigades by means of constantly acting production conferences, by means of the shop professional groups in order to increase the production of metal. It is necessary to search for and put into effect the reserves of production, to exert every effort for the successful utilization of the units again put into operation. It is extremely important to expand the struggle for the quickest introduction of the suggestions of the efficiency experts, by which the plants can save many millions of rubles.

The trade union organizations of the enterprises should render all possible help to those competing for the title of brigades and shock workers of Communist Labor, which is necessary in order to attain the creation of the conditions for fulfillment of the increased obligations.

The duty of the trade union committees is to organize the wide study and generalization of the working methods of the foremost workers of production and to publicize the competition widely. If all the workers can attain the level of the foremost workers the country will receive an enormous amount of metal in excess of the plan.

In order to fulfill the obligations which have been accepted, it is necessary to assure the widest possible distribution of the experience of the outstanding workers and the foremost collectives. A systematic exchange of experience and mutual assistance will favor the fulfillment of the socialistic obligations, the further technical progress, and, based on this, the increase in labor productivity and the increase in the output of metal.

ON THE USE OF THE TOBACCO ORES OF THE KERCH DEPOSIT

N. A. Gladkov and A. G. Ul'yanov

Institute of Ferrous Metallurgy, Academy of Sciences of the UkrSSR
Translated from Metallurg, No. 3, pp. 3-4, March, 1960

The Kerch iron ore basin is one of the largest deposits in the world, however, heretofore its reserves of cheap limonite have been utilized comparatively little due to the lack of an effective method of beneficiating the tobacco ores of the deposit which constitute about 80% of all reserves, and due to the presence of arsenic, which limits, to a known degree, the quality of rolled products.

Investigations of the tobacco ores for concentrating capacity showed that the only effective method of preparing these ores for smelting is the magnetic roasting process with subsequent magnetic concentration because the content of arsenic is considerably reduced during the concentration process.

During the first industrial magnetic-roasting concentration of the tobacco ores conducted at the concentrating mill of the "Sibélektrostal'" Plant with participation of the Institute of Ferrous Metallurgy of the Academy of Sciences, Ukraine SSR, the content of iron was increased from 37 to 51-52% and the arsenic content halved.

The Institute investigated the physical-chemical properties of the concentrate obtained, its capacity for nodulizing and sintering, and also the optimum conditions were established for fluxing ore of various basicity.*

According to its physical properties the concentrate can be related to finely crushed materials with a specific weight of 3.9 g/cm^3. The content of the 0.8 mm fraction in it exceeds 84%. The mineralogical composition of the concentrate is mainly oölites, which in a mixture with other components of the charge are satisfactorily nodulized without hindering normal sintering in a vacuum of 1000-1200 mm H_2O pressure.

The chemical composition of the concentrate is, %:

Fe_{total}	FeO	SiO_2	As	C
51	28	17	0.065	about 1

The sintering process of the nonfluxing ore in a basin from the concentrate of the magnetic-roasting concentration with a moisture content of the charge of 7.5-8%, carbon content in the charge of 4%, amount of recovery 30%, layer height of 300 mm, and with a vacuum of 1200 mm H_2O pressure is characterized by the following indices:

Vertical sintering rate, mm/min	11.3
Yield of the fraction +15 mm after screen analysis, %	94.2
Productivity of installation, tons/m^2·hr	0.97

Chemical composition of sinter, %

Fe_{total}	FeO	As
51.0	15.5	0.05

The yield of the fraction 0-5 mm after screen analysis was 3.4%, the screen number was 22.3.

The introduction of limestone into the charge helped to increase the sintering rate by improving the gas-permeability. However, with an increase in the basicity the granulometric composition of the sinter is worsened—the strength is reduced and the yield of the fine fraction increases. Thus under the constant sintering conditions cited above an increase in the basicity to 1.85 caused an increase in the sintering rate to 29.4 mm/min and an increase in productivity to 1.53 tons/m^2 hr. At the same time the yield of the fraction +15 mm after screening was reduced to 68.3%, and the yield of the fraction 0-5 mm increased to 9.8%. The screen number was increased to 26.0.

The chemical composition of the fluxing ore with a basicity of $\frac{CaO}{SiO_2} = 1.85$ is shown below, %:

Fe_{total}	FeO	SiO_2	CaO	As
38.2	12.2	12.8	22.9	0.048

* The study was conducted under the leadership of Corresponding Member of the Academy of Sciences of the UkrSSR, Doctor of Technical Sciences, Z.I. Nekrasov.

It is possible to improve the indices for the sintering of the fluxing ore of any basicity and also to improve its granulometric composition by increasing somewhat the carbon content in the charge. Thus an increase in the carbon content in the charge from 4 to 5% when sintering a highly basic agglomerate (CaO/SiO_2 = 1.85) increased the productivity of the sintering installation to 1.73 tons/m^2·hr instead of 1.53 tons/m^2·hr; the effective yield increased from 68.3 to 74.7% with a simultaneous decrease in the yield of the fraction 0-5 mm after screen analysis to 6.2% and the screen number to 21.9.

Thus the production of high-quality fluxing ore from concentrates of magnetic-roasting concentration of the tobacco ores does not present special difficulties. Even with a relatively low iron content (51%) the concentrate can be used successfully as a raw material for sintering.

An improvement in the process of magnetic-roasting concentration and a reduction in the cost of roasting by replacing the solid fuel with natural gas will create the necessary prerequisites for increasing the extraction of the Kerch ores.

* * *

SEALING THE LARGE AND SMALL BELL RODS

N. P. Maksimenko, A. Sakharskii, and N. I. Kartamyshev

Voroshilov Plant

Translated from Metallurg, No. 3, p. 4,
March, 1960

In 1955 the authors developed and introduced at the Alchevskii Plant, a simple construction of a seal for the rods of the large and small bells (see figure). This design consists of two sectional stuffing-boxes for sealing the large bell rod and one sectional stuffing-box for the small bell rod; lubrication is fed through the casing to the lubricating rings. The packing that is used is cloth split.

The device described has operated more than four years and no leakage of gas between the rods has been observed during this time. Experience has established that there is always a layer of lubricant on the surface of the rod even with its low expenditure. The packing holds up eight to nine months before the first small leaks appear.

The packing of the stuffing-box seal for the large bell rod on furnace No. 4 lasted eight months and the packing on blast furnace No. 3 has lasted three months. Gas leakages have not been observed in either case.

It should be noted that it is not necessary to supply steam to this structure or to water cool the casing.

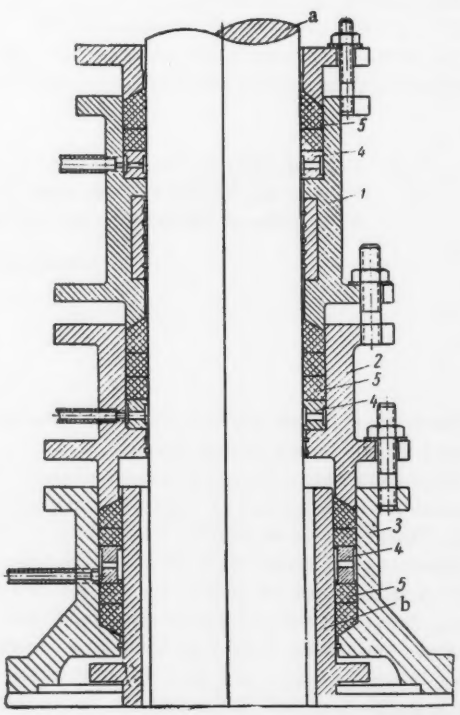

Figure. Stuffing-box seal of the large and small bell rods of the blast-furnace charging apparatus: a) large bell rod; b) small bell rod; 1 and 2) sectional stuffing-box for sealing the large bell rod; 3) sectional stuffing-box for sealing the small bell rod; 4) lubricating rings; 5) packing.

OPERATION OF HOT-BLAST STOVES

I. A. Ivanov

Hot-Blast Stove Attendant at the Blast-Furnace Plant of the Magnitogrosk Metallurgical Combine

Translated from Metallurg, No. 3, pp. 5,
March, 1960

It is known that increasing the blast temperature decreases the coke consumption. Blast-furnace workers therefore tend to use very hot blast. At many plants, the blast temperature reaches 950-1000°C, necessitating thoughtful and careful attention to the working of the stoves on the part of the attendants.

On starting work, the attendant first of all carefully inspects the hot-blast stove equipment and enquires about its working during the preceding shift. Having put the stove "on gas", he finds the optimum gas-air ratio by obtaining a flame of light blue color, and corrects the air supply in accordance with the pressure in the clean-gas line.

He selects the optimum amount of air for each stove by practice. In doing this, it is essential that the dome temperature should rise rapidly to the specified value.

For heating the stove checkerwork to a considerable depth, the air supply must be increased, the gas supply being correspondingly increased.

The heating up of a hot-blast stove can be judged from the dome temperature and the exit-gas temperature, which should increase gradually; the higher it is, the greater is the depth to which the checkerwork is heated. Excessively rapid increase in the exit-gas temperature means that the checkerwork is not being heated entirely throughout; it merely results in a useless increase in temperature of the space below the checkerwork and a reduction in the stove efficiency. Rapid increase in temperature of the exit gas should therefore be diminished by reducing the quantity of the products of combustion, i.e., by reducing the air supply, the gas supply being automatically reduced. Reduced air and gas supply should be continued until normal working of the stove is restored. It is irrational to reduce the exit-gas temperature by increasing the air supply, since this leads to cooling of the checkerwork.

Thus, in one hot-blast stove, the exit-gas temperature rose to 500°C, while the blast temperature was 910°C. For such a blast temperature, the exit-gas temperature may be lower, resulting in reduced gas consumption, increased stove efficiency and improvement in the work of the space below the checkerwork.

The exit-gas temperature was reduced to 400°C and normal working conditions of the stove were restored. This stove afterwards continued to maintain the specified blast temperature.

Heating up and through-heating of the stove checkerwork can also be judged from the quantity of cold air added to the blast. Satisfactory heating of the hot-blast stoves means that a greater quantity of cold air can be added to the blast. If hot-blast stoves are heated satisfactorily, the dome temperature (when working on "blast") falls gradually, while if they are not heated satisfactorily, the dome temperature falls abruptly.

Formerly, when the stoves were working on blast at a temperature of 900°C, some of the stoves had a large reserve of heat. Some of the attendants shut the stoves off after the latter had been heated up, others delayed putting them on heating for a time after taking them "off blast". In this case, the exit-gas temperature was high.

When a stove is closed down for repair, the quantity of blast-furnace gas is reduced. The stove attendant should then modify the working conditions of the equipment in good time, since the pressure in the clean gas line is not sufficient for working in the previously existing conditions. In such a case, the blast temperature must be reduced somewhat.

Raising the blast temperature to 1000°C demands more careful attention to the heating of the stoves. The dome temperature should be followed carefully (since sometimes there is insufficient gas and the dome temperature falls), as well as the gradual increase in exit-gas temperature. It is also necessary to keep a constant watch on the position of the gas valves, by which the quantity of added air can be judged.

The blast temperature is raised by 10-20°C in 24 hours, and is maintained at this level for one or two days. When the temperature reaches 950°C, the temperature should be maintained for a longer period until the stoves have accumulated a sufficient reserve of heat. In the period during which the blast temperature is being raised, it is undesirable to reduce the temperature for regulating the working of the blast furnace in the event of some slight disturbance. For this purpose, other methods of regulation should be used.

THE USE OF WASTE PRODUCTS CONTAINING TITANIUM FOR DEOXIDIZING STEEL

Engineers A. N. Vasil'ev and S. I. Bogachev

Kuznets Metallurgical Combine
Translated from Metallurg, No. 3, pp. 6-8, March, 1960

At the Kuznets Metallurgical Combine we investigated the possibility of utilizing waste products, such as shavings and sheet cuttings, high in titanium instead of ferrotitanium, when smelting steels 18KhGT and 30KhGT. These steels were smelted in 190-ton open-hearth furnaces with magnesite-chromite domes by the scrap-ore process. The content of liquid pig iron in the charge reached 65%.

The furnaces were heated by coke oven gas and producer gas with carburetion of the flame by resin. We measured the temperature of the metal during the smelting with a platinum–platinum-rhodium immersion thermocouple; the last measurement was made 5-6 min prior to deoxidation.

The steel was top poured through an intermediate ladle with two stoppers into the molds which were widened toward the bottom, with pig iron extensions of the lined shrinkage-reducer device. The ingots weighing 7.2 tons after blooming were rolled on a merchant mill into rounds with a diameter of 80-130 mm.

The experimental heats were conducted according to the operational technological specification up to the moment of final deoxidation in the ladle. The final deoxidation and alloying of the steel in the ladle were carried out according to the specifications in the following manner: While filling the ladle with the metal to 1/5 of its height all the ferrosilicon was poured from the stationary bunker, and then the ferrotitanium was poured from a chute suspended on the bridge crane. The delivery of the deoxidizer and alloying additives was completed when the ladle was three-quarters filled with metal.

The ferrotitanium, the expenditure of which was 2000 kg per heat, consisted on the average of 27% Ti, 8.5% Al; the size of the pieces was 50-180 mm.

In some heats the ferrotitanium was poured unevenly, and at a comparatively low temperature of the metal the large pieces did not dissolve at all, were slagged, and floated on the surface in the form of individual stickers.

During the teeming process the upper layers of the metal became saturated with titanium, and the silicon and manganese were reduced from the slag. Therefore the content of silicon, titanium, and manganese in the last one or two ingots was greater than provided for in the technical specifications, and these ingots were rejected. For example, during four months of 1959, 2.1% of the ingots which were defective due to chemical composition were not rolled according to specification.

During the experimental heats the order of adding the deoxidizers to the ladle remained the same as for common heats. The only difference was that aluminum (400 g/ton) and wastes of industrial titanium (550 kg per heat) in the form of shavings containing 95-96% Ti were added to the ladle instead of ferrotitanium.

Fifteen experimental heats were conducted using industrial shavings, of which 14 were with steel 18KhGT and one with 30KhGT. The data for 12 heats containing the addition of ferrotitanium were taken during the same period for comparison with the experimental heats.

In order to check the uniformity of the distribution of manganese, silicon, and titanium in the metal of five experimental heats we selected samples of steel from the second, tenth, twentieth, and last two ingots during the process of teeming. The results of the analysis showed that these elements are uniformly distributed in the metal from the beginning to the end of teeming; no substantial deviation from the heat analysis was observed; the metal meets the technical specifications.

In order to check the macrostructure in the finished rolled product we selected specimens from the rod heads of all ingots of the experimental and common heats.

An analysis of the results of this sampling of specimens showed that the quality of the macrostructure of the specimens taken from the rod heads was unsatisfactory in both groups of fusions. The number of rejected specimens in 14 experimental heats of steel 18KhGT was 28.7%, in one heat of 30KhGT was 7.7%, and in 12 common heats it was respectively 32.2% and 6.7%.

It was previously established that the quality of the macrostructure of steel 18KhGT becomes considerably worse when the temperature of the metal is reduced prior to deoxidation. It is apparent from Table 1 that the experimental heats have the best quality of macrostructure for both temperature groups, which is explained by the fact that in the heats deoxidized by the waste products of industrial titanium fewer deoxidizers are in the ladle.

The mechanical properties of the rolled products (80-130 mm diameter rounds) were checked against the

TABLE 1. Macrostructure of Steel 18KhGT with Respect to Temperature

Temperature of metal before deoxidation, °C	Groups of heats	Number		Defects of head templets, %		
					Including	
		Heats	Ingots	Total	Due to contamination	Due to central porosity
1660—1650	Exper.	2	57	14.0	10.5	3.5
	Common	4	127	15.8	12.6	3.2
1645—1610	Exper.	12	355	31.0	16.4	14.6
	Common	7	201	43.0	26.0	17.0

TABLE 2. Results of the Mechanical Testing of Experimental and Common Heats

Brand of steel	Groups of heats	Number of heats	Tensile strength (σ_B), kg/mm²	Yield strength (σ_S), kg/mm²	Specific elongation (δ), %	Specific necking (φ), %	Impact strength (a_K), kgm/cm²
18KhGT	Tech. spec.*		100	Not less than 90	9.0	50	8.0
	Exper.	14	106	102	14.0	62.0	
	Common	11	106	103	13.2	63.0	
30KhGT	Tech. spec.*		150	Not less than 110	9.0	45.0	6.0
	Exper.	1	172	154	10.0	48.0	8.1
	Common	1	165	156	11.5	49.5	9.7

* According to technical specifications.

TABLE 3. Consumption of Deoxidizers Introduced into Ladle

Deoxidizers	Experimental heats (14 heats)					Common heats (11 heats)				
	Introduced to ladle, kg	Content in finished steel, %		Consumption, %		Introduced to ladle, kg	Content in finished steel, %		Consumption, %	
		Titanium	Silicon	Titanium	Silicon		Titanium	Silicon	Titanium	Silicon
45% FeSi	485	—	0.29	—	8.0	305	—	0.29	—	9.3
Aluminum	78	—	—	—	—	—	—	—	—	—
Ferrotitanium	—	—	—	—	—	2000	0.098	—	64.2	—
Industrial shavings	540	0.095	—	64.3	—	—	—	—	—	—
Total	1103	0.095	0.29	64.3	8.0	2305	0.098	0.29	64.2	9.3

technical specifications. The mechanical properties of the metal of the experimental heats did not differ from the properties of the metal of the common heats and meet the technical specifications (Table 2).

The surface quality of the ingots of the experimental and common heats were practically identical.

Table 3 shows the average consumption of deoxidizing agents and alloying additives per heat of 190 tons for the experimental and common heats of 18KhGT-brand steel.

For the experimental heats the amount of material introduced into the ladle was reduced by 1200 kg per heat, the consumption of titaniferrous materials was reduced by 1400 kg, the consumption of ferrosilicon was increased by 150 kg, and aluminum by 78 kg. The consumption of titanium remained at the former level and the silicon consumption with consideration of the silicomanganese introduced into the ladle was reduced from 9.3 to 8.0%.

From the data on the industrial cost of deoxidizers and alloying additives we calculated the economic advantage of using titaniferrous wastes instead of ferrotitanium.

According to the experimental heats the following deoxidizers were consumed per ton of steel: 2.5 kg of 45% ferrosilicon, 0.4 kg of aluminum, and 2.78 kg of industrial titanium wastes. In terms of money this is 18 rubles and 73 kopecks per ton of steel. According to the common heats the consumption of deoxidizers in the ladle per ton of steel was: 1.55 kg of 45% ferrosilicon and 10.2 kg of ferrotitanium, which corresponds to 39 rubles and 68 kopecks per ton of steel. Thus, the saving

in substituting titaniferrous wastes for ferrotitanium is 20 rubles and 95 kopecks per ton of steel.

The following conclusions may be made on the basis of the experiments which we conducted:

1. The substitution of industrial titanium wastes for ferrotitanium does not cause technological difficulties and assures a uniform composition of the steel in the volume of the ladle.

2. Shavings high in titanium are dissolved in the ladle better than ferrotitanium due to which we eliminated rejects for chemical composition when teeming ingots.

3. The macrostructure of the specimens from the rod heads is somewhat better in the experimental heats. The best macrostructure quality in the rolled products was obtained for the heats with a temperature of the metal prior to deoxidiation of 1650-1660°C.

4. The surface quality and the mechanical properties of both the experimental and common heats were virtually identical.

5. The consumption of titanium for both groups of heats was 64%; the consumption of silicon in the experimental heats was 8%, i.e., 1.3% less than in the common heats.

6. The use of the waste products of industrial titanium made it possible to save approximately 21 rubles per ton of melted steel.

Since April, 1959 we have been using the waste products of industrial titanium instead of ferrotitanium at the Kuznets Combine for the entire output when melting steels 18KhGT and 30KhGT. Such a substitution was also accomplished when melting steels of all brands (18KhGT, 30KhGT, 15KhSND, 10KhSND, etc.).

* * *

REMOVING SULFUR AND PHOSPHORUS IN AN ACID ELECTRICAL STEEL-MELTING FURNACE

V. I. Ivanov

Lugan "October Revolution" Locomotive Plant

Translated from Metallurg, No. 3, pp. 8-9, March, 1960

In basic electric arc furnaces the melting of steel is much more expensive than in acid furnaces since the output of basic furnaces in the melting of the same types of steels is 1.3-1.5 times lower than the output of acid furnaces. There is a correspondingly higher consumption of electrical power and electrodes for 1 ton of steel. Furthermore, the cost of materials for dressing the furnace and burning-in the hearth is much more expensive than quartz sand which is used to dress acid furnaces.

Nevertheless, many plants which do not melt high-manganese steels have to use a basic lining in the furnaces for removing sulfur and phosphorus from the metal because it is not possible to use in the remelting a metal which is free from sulfur and phosphorus.

The Lugan "October Revolution" Locomotive Plant had to smelt alloyed steels (5KhNV, 4KhS, 20KhN3A, Kh18N25S2, Kh20N14S2, etc.), the content of sulfur and phosphorus in which should not exceed 0.03%.

Despite the fact that the production of this steel was only 7-10% of the annual output of the 8-ton furnace, the plant had to have one electrical furnace with a basic lining.

The plant engineers V. P. Perov, V. V. Zhikhor, and V. A. Val'demirov and the author of the present article carried out work on the partial removal of sulfur and phosphorus in an acid furnace in order to avoid melting alloyed steels in a basic furnace and lining the furnace with acid material.

TABLE 1. Reduction in the Content of Phosphorus During Melting

Content of P in bath, %	Content of P in finished metal, %
0.035	0.029
0.033	0.027
0.030	0.025
0.035	0.026

At first during fusion of the charge after tapping a part of the first slag, an iron-limestone slag was added to remove the phosphorus; it consisted of 2.5-3 kg of dry iron ore and 5-6 kg limestone for 1 ton of steel.

This slag was completely removed after 20-25 minutes. The phosphorus content was reduced by 0.005-0.01% (Table 1).

In order to reduce the melting time, M. I. Topaller tested the addition and removal of iron-limestone slag up

TABLE 2. Content of Phosphorus in Bath and in Metal Using the New Method

Content of P during fusion, %		Content of P in finished metal, %
Expected content using old method	Obtained using new method	
0.040—0.035	0.025	0.026
» »	0.026	0.025
» »	0.024	0.025
» »	0.023	0.024
» »	0.026	0.029

to complete fusion of the bath. The phosphorus content was then reduced by 0.005-0.015% (Table 2).

The optimum compositions of slags during fusion are given below in %:

CaO	SiO_2	FeO	MnO	Fe_2O_3	Cr_2O_3	P_2O_5
13.50	49.5	21.72	11.88	1.61	0.61	0.09
9.15	40.35	25.24	12.54	2.38	0.12	0.16
15.52	48.45	19.92	11.68	0.51	0.40	0.05

For partial removal of the sulfur after tapping the iron slag, a new slag was produced by adding freshly roasted lime (8-10 kg/ton charge) and 2-2.5 kg/ton fireclay under the electrodes. During the melting, the power of the transformer was increased.

After 15-20 minutes soaking the slag was completely removed and a deoxidizing slag was formed by adding a mixture of limestone, sand and fireclay to the extent of 2% of the metallic part of the charge in a ratio 1.2 : 1 : 1 (i.e., for an 8-ton furnace 7.5 kg/ton, 6 kg/ton, 6 kg/ton). At the same time, ferromanganese was added to give the steel a manganese content of 0.15-0.20%.

The change in sulfur content in the bath is given in Table 3.

TABLE 3. Change of Sulfur Content in Bath

No. of heat	Content of S, %		Grade of steel	Total melting time including dressing of furnace, hours-min
	During fusion	In finished metal		
5980	0.039	0.030	5KhNV	4—05
69171	0.038	0.030	4KhS	3—35
69218	0.038	0.025	20KhN3A	4—13
59155	0.037	0.028	20KhN3A	3—42
69251	0.029	0.019	Kh18N25S2	3—32
59193	0.030	0.015	Kh18N25S2	3—26
59335	0.041	0.030	20KhN3A	3—45
59329	0.036	0.025	20KhN3A	3—37
59374	0.037	0.030	5KhNV	3—35

As can be seen from Table 3, the sulfur content was reduced by 0.007-0.015%. The state of the hearth slopes after heats using the described method of refining differed little from heats using the ordinary method.

After tapping an ordinary heat, 5-8 minutes is usually taken up on dressing the furnace; the same amount of time was needed for the above heats.

The optimum compositions of the slags for desulfurization are given below, %:

CaO	SiO_2	FeO	MnO	Fe_2O_3	Cr_2O_3	P_2O_5	S_{total}
14.6	55.8	6.94	11.06	0.61	1.47	0.05	0.11
8.26	55.2	6.97	13.41	1.37	0.5	0.06	0.10

The introduction of this new method made it possible to organize the melting of alloyed steels in an acid electrical furnace. The steel meets the GOST requirements and is used successfully in the departments of the plant.

* * *

THE USE OF CHROME-MAGNESITE CONCRETE FOR LINING TROUGHS

A. A. Pirogov and E. N. Leve
Ukrainian Scientific Research Institute for Refractories

E. P. Dryapik, L. A. Malakhovskii, and I. I. Nevidimov
Alchev Steel Plant

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In Soviet steelmaking practice the most common material for lining steel tapping troughs of open-hearth furnaces is fireclay brick. The life of a working layer of fireclay lining for troughs varies from 1 to 5 heats, which means there is a large consumption of refractory in overhauls.

At the Alchev Steel Plant the working layer of fireclay lining in the troughs of the 250-ton open-hearth furnaces usually lasted 1-2 heats; the consumption of fireclay brick was then 3.0-3.3 kg/ton of smelted steel.

Wear in the fireclay lining of the troughs is due to chemical attack on the brick under the action of the

molten metal and slag, and also due to mechanical damage to the lining during transporting and cleaning incrustations from the troughs.

When replacing the fireclay lining with a monolithic lining by ramming, it is possible to achieve a considerable reduction in the consumption of refractory material.

In Soviet steelmaking practice there is a certain amount of experience in using a monolithic lining in troughs, consisting of carbon fireclay-clay mass (Stalinc Steel Plant); however the life of this lining is usually only 15-20 heats.

To prepare a monolithic lining of single troughs in the 250-ton open-hearth furnaces at the Alchev Steel Plant, tests were carried out with a chrome-magnesite concrete on periclase cement of the following composition, %:

Filler

Ground chromite ore with grain coarseness less than 4 mm 60
Magnesite powder of grain coarseness less than 3 mm 10

Binder

Finely ground magnesite powder (through a sieve with 4900 holes/ /cm^2, 85% of material passes) 30
Magnesium sulfate ($MgO \cdot 7H_2O$) 2
(above 100%)

Concrete with this composition sets in air and then acquires high mechanical strength at ordinary temperatures. At high temperatures the setting of the concrete is sharply accelerated. As regards its metal and slag resistance and also its refractory properties, chrome-magnesite concrete (according to studies at UNIIO) is equivalent to chrome-magnesite refractories but differs from them in its somewhat lower thermal conductivity.

Experimental concrete linings for single troughs were prepared in the following way.

Metal pins of length 160 mm and diameter 16.5 mm were welded onto the internal surface of the trough at a distance of 200 mm from the top edge at distances of 150-200 mm from one another in one row.

The bottom of the trough and the side walls up to the line of pins were laid in one row with fireclay brick on fireclay-clay solution. The brick lining was dried with gas after which a wooden mold was set up and the concrete mass was rammed by means of a pneumatic rammer.

Before the start of ramming, the concrete mixture was moistened with an aqueous solution of magnesium sulfate of density 1.28 g/cm^3; the amount of solution used was 3 liters per 100 kg mixture.

The second row of pins was not welded but was placed in the concrete mass with ramming at a distance of about 150 mm from the first row.* The thickness of the side walls of the rammed concrete lining was 115 mm, that of the bottom was 130 mm. The ramming of the lining of one trough used 1300-1500 kg of chrome-magnesite mixture. The ends of the trough near the furnace were lined with magnesite brick in two rows along the length of the lining, at the opposite end with the fireclay brick also in two rows.

After a day, the concrete lining set in air and acquired a sufficiently high strength and the wooden mold was removed. The lining was dried with a gas burner for 2-3 days, the burner being placed along the walls of the trough (Fig. 1).

After drying, the lining of the trough was lubricated with a fireclay-clay solution of thickness 15-20 mm with the following composition: 80% fireclay powder of grain size less than 1 mm, 20% ground refractory clay and 1% sulfite-alcohol residual liquor.

The experimental troughs with a monolithic concrete lining with protective lubrication lasted 170-190 heats. Various types of steel were tapped. The pouring of the metal of all heats took place normally.

To keep the concrete lining of the trough in working order, incrustations were removed after each heat and the working surface of the lining was lubricated with a

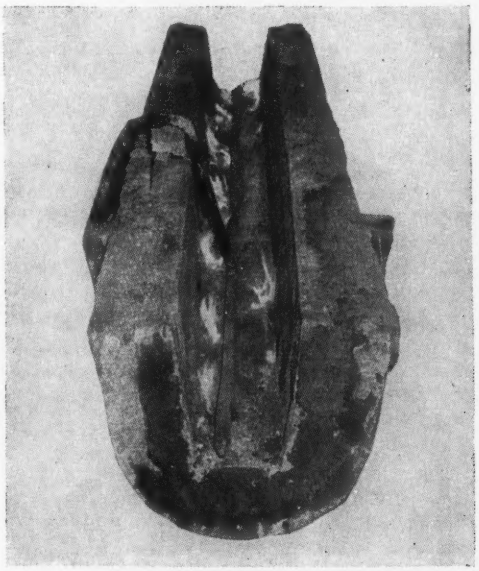

Fig. 1. Drying the trough with rammed lining.

*Experiments showed that concrete bonds well with the metal shell, so that in later work reinforcing pins were not used.

fireclay-clay solution. Observations showed that in the cleaning of the trough the incrustations are much more readily removed from the lubricated monolithic concrete lining than from a lining without lubricant. The properties of the lubricant are improved by adding graphite (5-10%).

Local damage in the chrome-magnesite concrete lining in the trough is periodically repaired by a concrete mass of plastic consistency with the same composition (Fig. 2).

The concrete adheres well to the hot surface and rapidly sets. Due to the intensive wear, the brick lining of the trough ends had to be removed after each 3-4 heats.

After carrying out the experiments, all troughs of the 250-ton furnaces were converted to monolithic lining with chrome-magnesite concrete using fireclay-clay lubrication on the working surface.

The consumption of fireclay brick in the repairs on the troughs was reduced from 3.3 to 0.4 kg per ton of smelted steel; the consumption of chrome-magnesite concrete is 0.1 kg per ton of steel. To prepare concrete linings on the troughs it is advisable to use basic refractory scrap; the concrete can be densified by the vibration method.

Fig. 2. A view of the repaired lining after 95 heats.

* * *

USE OF SUPERHEATED STEAM IN THE OPERATION OF OPEN-HEARTH FURNACES

V. I. Peredistyi

Head of Production Section of Open-Hearth Plant No. 3,
Dzerzhinskii Works

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March, 1960

Oxygen had been used for some time at open-hearth plant No. 3 of the Dzerzhinskii Works for melt-down intensification, but toward the end of December, 1957, the oxygen began to be used for other purposes. High-pressure compressed air was not available. Workers in the heat-engineering laboratory suggested that steam from the waste-heat boilers at a pressure of 12 atm and a temperature of 330-350°C should be used as intensifier. The steam was introduced into the working spaces of the furnaces through pipes mounted in water-cooled tuyeres arranged laterally about the gas-port water-cooling elements. The steam jet entering the base of the flame intensifies its pick-up of regenerator air, accelerates the combustion process and imparts considerable straightness and rigidity to the flame. In some furnaces, superheated steam was led to the water-cooling elements in 4-inch diameter pipes. The reversing valves used were locomotive blow-off valves of "Everlast" type. Reversal of the valves was by servomotor, which operated the instant the air valves were turned. In other furnaces the supply of superheated steam has been effected in a much simpler manner: The steam passes from the waste-heat boiler along a steam pipe to the oxygen pipe and then into the furnace.

The use of steam as intensifier has resulted in a considerable saving. All the control and measuring apparatus used with oxygen is also used when working with steam, without any changes. The beneficial effect of the steam was shown clearly in the very first heats: The duration of the heat was cut down mainly in the melting and finishing periods, and the specific fuel consumption was also reduced.

The considerable efficiency in the use of steam is due to its participation in the thermal and technical processes occurring in the working space of the furnace. In addition to its mechanical effect on the form of the flame, steam contains 89% oxygen and is an active oxidizer in the conditions of the working space of an open-hearth furnace, and therefore it takes an active part as chemical agent in the combustion process and in the oxidation of the bath. The combustion of carbon and heating of the bath are accelerated, which promotes the degasification of the metal and the liberation of the slag inclusions.

As a result of the investigations, it was found advantageous to use steam from the commencement of charging to the lime boil. The average steam consumption is 1200 kg/hr for 185-ton furnaces and 1500 kg/hr for 370-ton furnaces. In using superheated steam, it is very important that the pressure should be constant. In the winter season, the steam pressure drops to 7-8 atm; at the same time, the efficiency of the use of superheated steam is also lower.

Superheated steam is very reminiscent of oxygen in its action on the melting processes. Its use, however, involves a much lower capital expenditure on equipment, and low operating expenses, due to its low cost. Until recently, the cost of 1 m^3* of oxygen in the conditions of our works was 14-16 kopecks, while the cost of 1 kg of steam from the waste-heat boilers is 1.2 kopeck. Currently the plant is operating successfully with superheated steam. The duration of a heat in a 185-ton furnace has been reduced to 6 hr 30 min; in a 370-ton furnace, to 10 hr 30 min - 11 hr. The specific fuel consumption has dropped considerably. Thus, in August, 1959, the specific fuel consumption of the plant was 139 kg/ton, instead of 153 kg/ton according to the plan.

* At standard temperature and pressure.

* * *

IMPROVING THE DESIGN OF ROOF SUSPENSIONS FOR AN OPEN-HEARTH FURNACE

E. M. Kondrat'ev and V. F. Perebeinos

Stalino Steel Plant

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In May, 1958, at the Open-hearth Department of the Stalino Steel Plant, an improved design was introduced for the suspension system used to fasten the chrome-magnesite roof of the open-hearth furnace.

The old design consisted of a rectangular suspension with a hole for a horizontally placed wedge and packings which were placed between the wedge and the strip of the cross-bar (Fig. 1). In operation this system had serious faults, as a result of which separate parts of the roof were not suspended due to wedges or packing falling out. The wedges and packings were often knocked out by the action of the compressed air jet during the daily removal of dust from the roof and also under the action of other external factors.

For these reasons this type of wedge joint could not operate for long in the horizontal position and tended to unwedge itself. Since the chrome-magnesite roof must be in the suspended condition, the roof had to be fastened several times during a furnace campaign, i.e., the fallen wedges or packings had to be replaced in the suspensions. This was done by a gang of fitters working under high temperature conditions which affected the quality of the fastening. At the end of the campaign, due to absence of wedges in a number of suspensions, the roof sagged, it lost its shape and collapsed. The authors suggested changing the design of the suspension unit. The new suspension consists of two wedges operating in the vertical position (see Fig. 1). With movement of the roof upward , since this allows a gap between the lower strip and the end of the distance tube, the wedge-shaped suspension moves and is wedged by the stopper wedge (Fig. 2). These two wedges, operating on the principle of self-wedging, do not permit the roof to sag and at any instant it is in the suspended condition.

With this system of suspension it is not necessary to have repeated fastening of the roof during a furnace campaign. Furthermore, whereas in the previous system the wedges had to be inserted 20-30 heats after the start of the campaign (which sometimes could not be done satisfactorily), in the proposed system the wedges are inserted immediately after knocking out the casing of the roof, when it has a low temperature. After stopping the open-

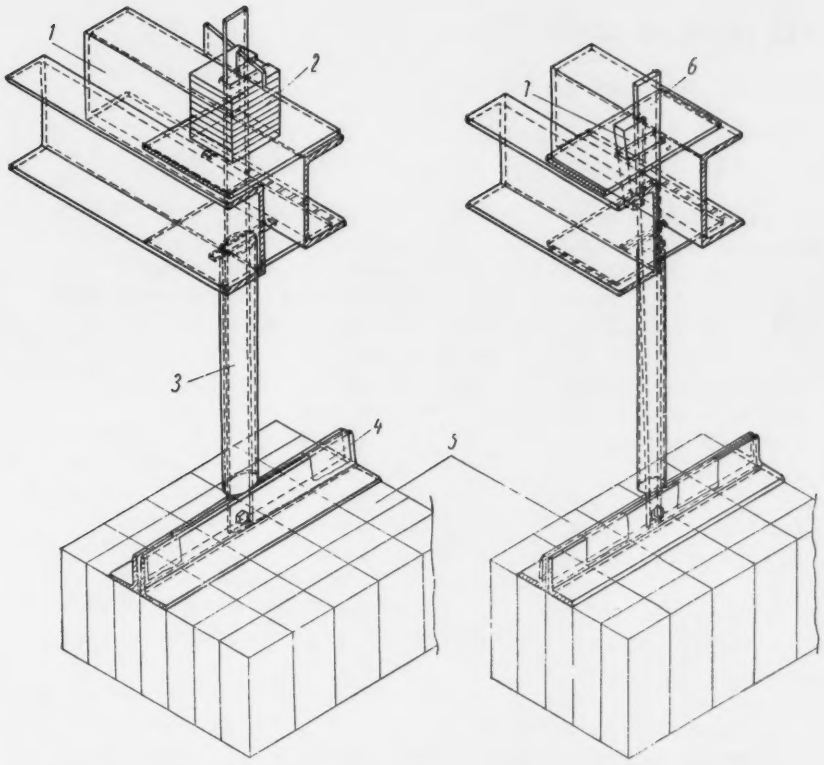

Fig. 1. Suspension system for fastening roof. Left—old design, right—new design: 1) cross-bar; 2) packing; 3) distance tube; 4) support corners; 5) roof; 6) wedge-shaped suspension; 7) stopper wedge with groove.

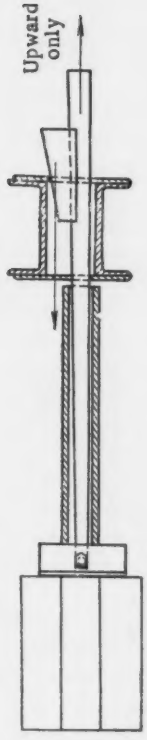

Fig. 2. Action of wedge.

hearth furnaces for cold repair where the new suspension system had been used, it was possible to save a considerable number of wedges and suspensions for further use.

All open-hearth furnaces of the Stalino Steel Plant now use this new suspension system.

Prolonged operation of roofs with the new fastening system has shown that the improved roof suspension unit, working on the self-wedging principle, has a number of advantages over a unit where the roof is suspended with horizontal wedge:

a) the initial fastening of the roof (installing the wedges) is carried out after knocking out the casing before heating the furnace;

b) it is no longer necessary to have repeated intermediate fastening of the roof during the furnace campaign;

c) considerable savings are achieved in the suspensions and wedges due to their further use after cold repair of the furnace.

* * *

USING 16.5 m³ CAPACITY SLAG LADLES

I. I. Vinioli and V. A. Zhitkov

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To improve the slag handling and facilitate servicing at the 500-ton open-hearth furnaces of the Voroshilov Plant in 1959 slag ladles of 16.5 m^3 capacity were used.

The amount of slag in a 500-ton heat is 16-17% of the weight of the charge, i.e., about 87 tons or 50 m^3 (with an average volumetric weight of the slag of 1.75 ton/m^3). Using four 11 m^3 slag ladles for one heat did not completely remove the slag from the furnace. The large slag layer reduced the heat transfer from the flame to the bath, as a result of which there was a reduction in the annual output of the furnace. The production figures for 1958 showed that the average time of a heat in the 500-ton furnace was 13.85 hours when using 11 m^3 slag ladles.

Using four 16.5 m^3 slag ladles for one heat leads to considerable increases in the amount of slag removed, increases the heat transfer in the furnace and reduces the time for a heat. Thus, by replacing 11 m^3 slag ladles by 16.5 m^3 ladles (from data for 5 months of 1959) the average time for a heat in the 500-ton furnace was reduced to 13.05 hours, i.e., by 40 minutes.

With an hourly output in the 500-ton furnace of 37 tons, reduction in the time for a heat by 40 minutes makes possible the additional smelting of about 45 tons of steel per day.

The introduction of 16.5 m^3 slag ladles sharply reduced the holdups in heats due to late arrival of the ladles. When the 500-ton furnace was serviced by small ladles the holdups averaged 34 hours per month; on changeover to the 16.5 m^3 ladles the holdups were only 4 hours.

The 16.5 m^3 slag ladles are carried by the new UZTM slag cars which are being widely used in blast-furnace departments. The design of the new Uralmashzavod slag car has a number of advantages, ensuring reliability and smoothness of operation of the tilting mechanism. The slag car consists of a carriage resting on two double-axle normal gauge trolleys, a cast steel bearing ring and removable slag ladle. The ladle has a tilting mechanism with an individual 28 kw drive. The slag car mechanisms are lubricated centrally from a manual lubrication station.

The tilting mechanism on the slag car has two screws with a right-hand thread; the nuts are fastened in the cross-beam connected with the trunnion of the bearing ring. The presence of two screws and nuts provides smooth operation of the mechanisms.

On the trunnion of the bearing ring there is a stationary gear sector in mesh with a toothed rack.

The motion-disconnecting switch stops the motor at the extreme tilted positions, preventing slag pouring onto the railroad tracks.

The ladle is tilted by means of a command controller and has remote control. To feed the power circuits and the control circuits on the slag car there is a transportable, flexible cable, one end of which is permanently connected to the control panel; the other end is connected to the transportable plug socket.

On the frame of the slag car there are two plugs to connect the transportable cable on both sides of the slag car. When the flexible cable is connected on one side of the ladle it always tilts in the opposite direction.

The first experience in operating two slag cars at the 500-ton open-hearth furnace of the Voroshilov Plant has shown their definite advantages.

Operation has confirmed the reliability of the tilting mechanism, whereas the mechanism of the Stal'proekt slag car with an 11 m^3 ladle had insufficient strength; there were cases where the nuts were torn from the screw.

* * *

MOVING AN OPEN-HEARTH FURNACE WITH A REFRACTORY LINING

V. N. Mash'yanov

Chelyabinsk Building Department of the "Uraldomnaremont" Combine
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March, 1960

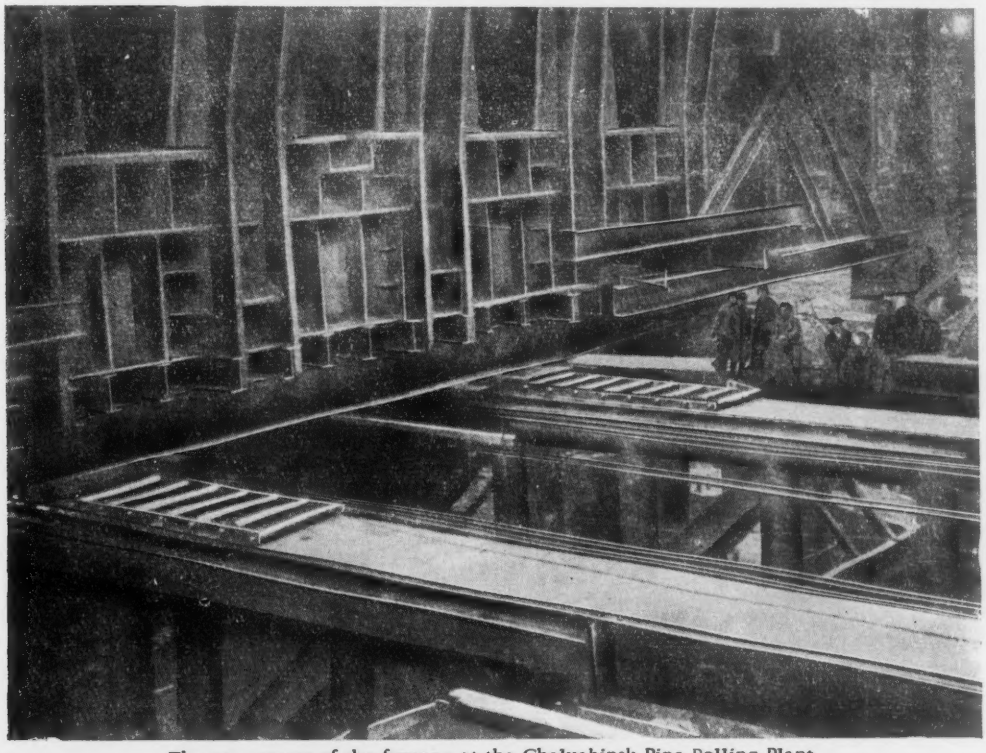
In the open-hearth departments of steel plants the general overhauls on the furnaces are carried out under difficult conditions: near the operating furnaces and with high loads on the cranes.

In recent years the "Uraldomnaremont" Combine Building Department has carried out a number of general overhauls with the movement of metal constructions of the upper and lower structures of the furnace as a supported unit.

Following from the decisions of the 21st Conference of the Communist Party of the Soviet Union on the efficient utilization of capital investments, the repair workers started to move the upper structure of the furnace with the previously laid refractory lining. The general overhaul of the open-hearth furnace was carried out with this method in October 1959 at the Chelyabinsk Pipe Rolling Plant in accordance with the local conditions in the department. The furnace was moved by rolling along metal columns on rollers.

In the casting bay alongside an operating furnace, a more powerful open-hearth furnace was installed and a cooled armature with pipes. The refractory lining of the hearth was laid in the assembled block, the inclines of the front and back walls; the central part of the main suspended chrome-magnesite roof and the roof suspension was also installed.

Special metal columns were prepared to move the furnace. Along the metallic floor consisting of 2.7 x 2.7 m joists of thickness 250 mm, crossties were laid at a distance of 200 mm from one another and bundles of seven R-50 rails. The stress on the ground from the assembled unit was 3 kg/cm^2. At the top of the columns there was



The movement of the furnace at the Chelyabinsk Pipe Rolling Plant

a 30 mm thick sheet, and then metal rollers of diameter 100 mm, collected in a frame with 350 mm spacing. During the movement, the front free frame with the rollers was pulled and directed by hand winches during movement of the block along the columns.

Two assembly winches were used with two hoisting tackles each with eight 19.5 mm cables. The calculated force for the movement was 15 tons; the hoisting tackle was designed not for the tensile forces but in order to maintain a rate of movement of the furnace of 12-15 mm/sec. The correctness of the movement was checked by means of a tight transverse axis of the furnace from cable and check indicators fastened on both sides of the furnace. The accuracy of the movement along the longitudinal axis was 20 mm; along the transverse axis the furnace was kept precisely in the planned position.

The rollers along which the movement took place were not removed from under the strengthened unit; additional supports were made between them so that the upper structure could rest on permanent ferroconcrete columns.

To maintain the planned height level of the top of the furnace, before moving the strengthened unit, the main columns were reduced by the 100 mm height of the roller, which eliminated the necessity for lifting the furnace on jacks in order to free the rollers and then lowering the furnace onto the columns. The whole operation took 1 hour 30 minutes.

The installation of the open-hearth furnace at the Chelyabinsk Pipe Rolling Plant by the method of moving with a refractory lining was carried out in 6 days 4 hours, whereas the construction of the open-hearth furnace with the normal methods takes 10-12 days. The general overhaul of the furnace was made to coincide with the redesigning. The redesigning increased the furnace output by 25%.

A similar open-hearth furnace overhaul at the Chelyabinsk Steel Plant in January 1959 by the method of moving the upper structure of the furnace without refractory lining was completed in 11 days. Using the new method reduced the overhaul period by 5 days.

TRENDS IN THE DEVELOPMENT OF MILL GUIDES

V. P. Fedin, I. F. Prikhod'ko, and N. F. Gritsuk

VNIIMETMASh and Magnitogorsk Metallurgical Combine
Translated from Metallurg, No. 3, pp. 17-22, March 1960

Until 1950, rolling mills in the USSR were equipped exclusively with sliding mill guides. At present, in addition to the sliding guides, roller guides, which involve the movement of rolled pieces on rollers mounted in the guide frame, are frequently used.

The existing mill guides can be classified according to the following criteria: a) location on the stand; b) design of the guides themselves; c) the type of friction between the rolled piece and the working parts of the guides.

According to the position in the stand the guides are divided into entry and delivery guides.

In the design of the guides, one takes into account the required position of the section before it enters the pass, the need for preventing the stock from turning and also for preventing the stock from lateral displacements.

The pass arrangement is of vital importance for the design of the entry guides. If the stock is self-aligned by the roll grooves there is no need to enter it into the pass very accurately or to prevent it from turning during the rolling process. At the same time unstable sections must be reliably prevented by the guides from turning and from lateral displacement during the rolling process. Therefore, depending on the actual conditions of rolling, the entry guides are of different design.

The delivery guides keep the stock in the right direction when it leaves the rolls, prevent the ends of the stock from bending due to the downward or upward pressure, nonuniform heating and nonuniform deformation. Reliable delivery guides ensure a correct entry of the piece to the repeaters and into the entry guides of the next stand.

Guides and manipulators play an important part in continuous and looping mills with repeaters.

If the manipulators are worn, the rolled piece is not turned through the required angle and does not enter the next stand in the required position. As a result, the section is distorted and the output of acceptable product is reduced. Metal particles which become attached to the rolls and to the working surface of the delivery guides frequently cause jamming of the front ends of the piece and stoppages of the mill.

The sliding of the rolled piece on the guide surface was replaced by a rolling movement on rollers, first at continuous billet mills and in the entry guides of section mills rolling alloy steels.

The great advantages of roller guides over sliding guides meant that they were extensively adopted.

As a rule, sliding guides are used for the rolling of shapes (H-beams, channels, rails, etc.). The reason is that sliding guides are of simpler construction than roller guides. There exist, however, designs of roller guides used for the rolling of angles and other shapes.

During the rolling of simple sections (rounds, squares, strips, etc.) roller guides are more and more widely introduced, in particular on medium-section, light-section and wire mills.

Rolling practice abroad and in the USSR indicates that a system with a single pair of rollers, for instance entry boxes with rollers mounted on flat springs, will be introduced as a standard design of roller guides.

Similar guides are used on the finishing stands of the section mills at the Magnitogorsk Metallurgical Combine, Chelyabinsk, Makeevka, Stalino, Krivoi Rog, "Serp i Molot" Works.

Entry guides of this design have the following advantages: easy adjustment, reliability in preventing the rolled piece from turning and from lateral displacement, and a much smaller force required for pushing the piece between the rollers than with multiroller guides.

Relatively long guides, usually mounted in front of the rollers, ensure a reliable operation of the guides with one pair of rollers even on the looping mills.

The guides of the finishing stand of the 300 medium-section mill at the Magnitogorsk Metallurgical Combine

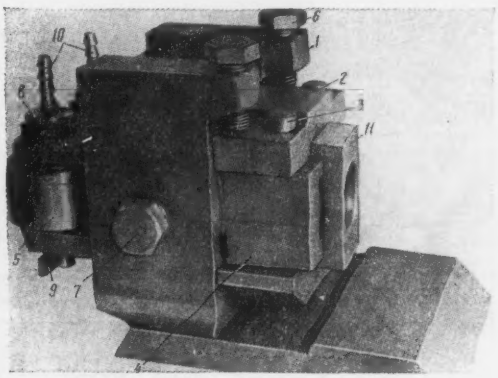


Fig. 1. Entry guide on the finishing stand of the 300-1 mill at the Magnitogorsk Combine: 1) box; 2) turning frames; 3) pin; 4) guide bar; 5) roller; 6) fixing bolt; 7) adjuster bolt; 8) axle; 9) cotter; 10) nipple; 11) trumpet.

(Fig. 1) represent a most satisfactory design which meets usual requirements of the operation of entry roller guides. In addition to the advantages enumerated above, it has an additional one: The rollers can turn about the axis of rolling which is necessary to obtain the correct shape. The turning is effected by a bracket attached to flat springs, on ends of which the rollers are mounted.

The use of rollers is not limited to the entry guides. In recent years a number of successful designs of delivery roller guides have been developed. Rollers mounted in the side guides reduced the number of defects, most of which usually occur during the frictional contract of the stock with the buffer plates and not with guides.

Usually the majority of the designs of roller equipment for delivery guides and turning guides have sliding guide shoes between the rolls and the rollers. The shoes have the same function as in the sliding guides - they remove the pieces from the rollers, prevent the bending of the front end of the piece and prevent the piece from wrapping around the rolls.

The operational experience of continuous section and billet mills shows that during the rolling of simple sections (rounds, squares) the rolled piece does not jam in the finishing passes. Therefore, the delivery guide shoes on the finishing stand can be replaced by guide trumpets* (Fig. 2).

This substitution, combined with the introduction of rollers, considerably simplifies the design of the delivery guides, makes adjustment easier, permits a quick change of rolls and a quick change from one pass to another, and also eliminates the stoppages of the mill which were due to the dislodging of worn sliding guides and consequent complications.

Similar guides of a trumpet-form are fairly widely used on wire mills and light-section mills.

The advantages of using turning rollers (design proposed by S. V. Merekin) on continuous billet mills and continuous section mills in our country were confirmed by experience. Inadequate rigidity and unstable adjustment because of a low durability of the textolite bearings used in the initial design were eliminated when the turning rollers were modernized at the Makeevka Metallurgical Works (modification proposed by V. F. Laganskii and K. V. Kuchevskii).

The turning rollers are mounted in a special stand located very near the working stand. The supporting parts of the rollers have roller bearings which improve their durability.

The turning rollers can now be considered the best type of delivery guides for continuous billet mills and roughing stands of section mills.

Figure 3 shows delivery roller guides designed by the Yuzhuralmashzavod for a continuous 730/500 billet mill. It should be mentioned that the original installation of the entry rollers together with the turning delivery rollers at this mill was not successful. The rollers with intermediate guide trumpets instead of open sliding tables complicated the adjustment of the opening between the rolls.

Experience shows that at continuous billet mills and at finishing groups of continuous section mills at which large simple shapes are rolled and have to be turned between the stands, ordinary entry tables can be successfully employed at the front end of the stands. A welded construction of these tables is advisable. Water cooling prevents the tables from warping under the effect of the high temperature.

Roller straighteners have a special place in the guide equipment of continuous rolling mills. They are not linked with the delivery guides and are located behind the finishing stands of continuous billet and section mills. The straighteners prevent the pieces leaving the finishing stand from twisting before they enter the cooler.

* Proposal of N. F. Gritsuk

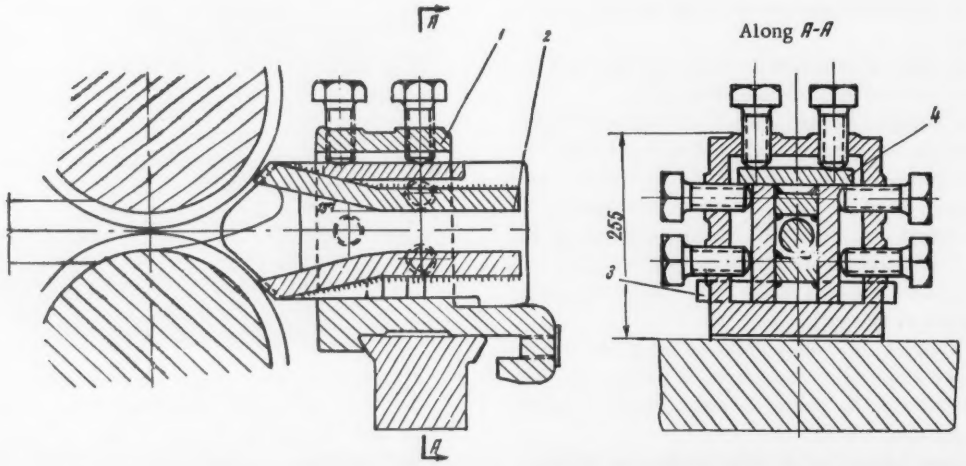


Fig. 2. Receiving trumpet guide: 1) box; 2) trumpet; 3) mounting block; 4) plate.

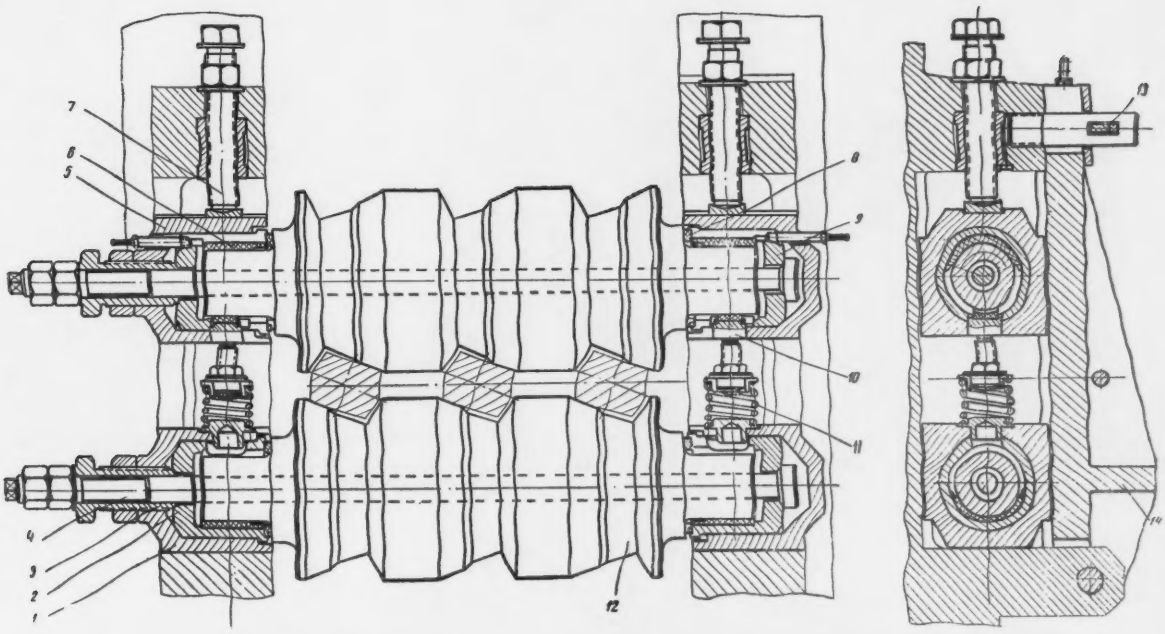


Fig. 3. Delivery and turning guide on the 730/500 sheet-billet mill: 1) lower chock; 2) lower bearing box; 3) adjusting screw; 4) pull rod; 5) upper chock; 6) bearing; 7) adjusting screw; 8) thrust bearing; 9) upper bearing box; 10) balancing screw; 11) screw; 12) roller; 13) cotter; 14) hinged plate.

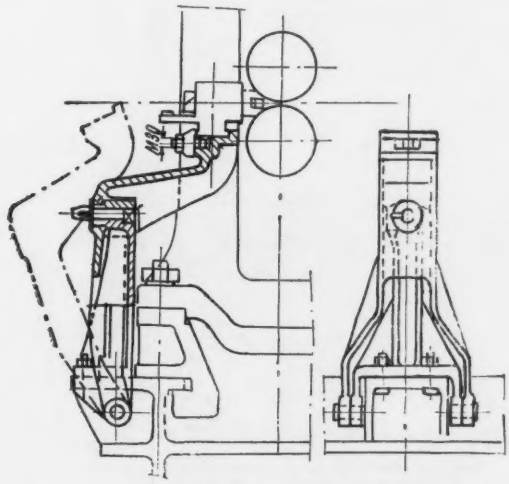


Fig. 4. Mounting of the entry guides on the block.

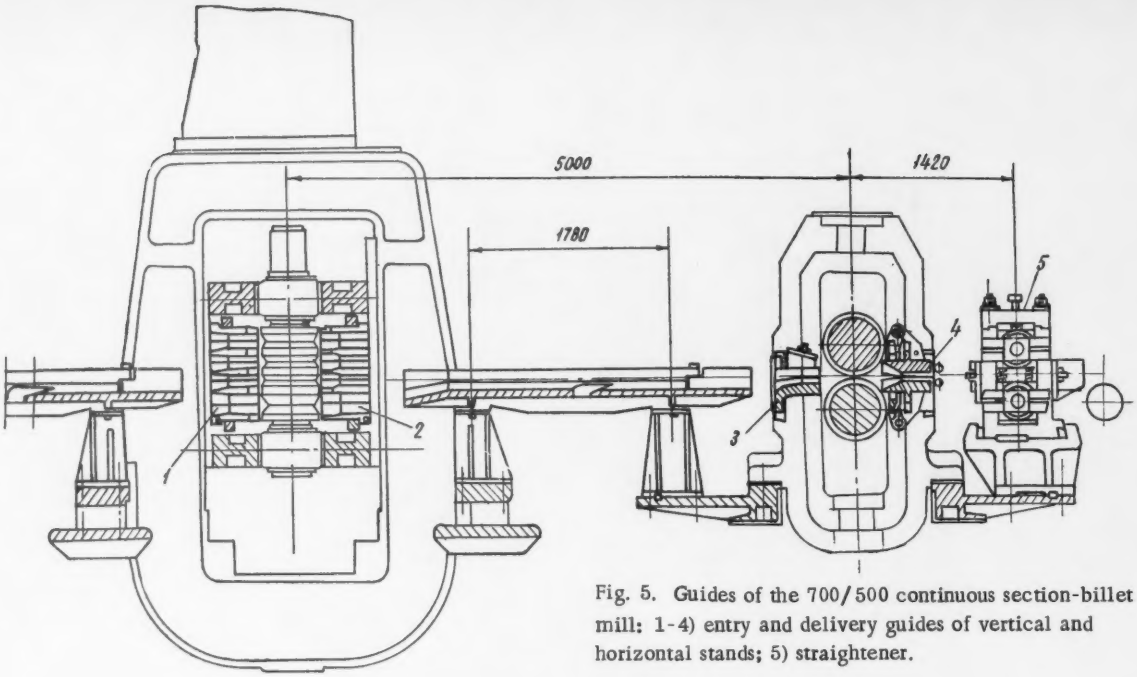


Fig. 5. Guides of the 700/500 continuous section-billet mill: 1-4) entry and delivery guides of vertical and horizontal stands; 5) straightener.

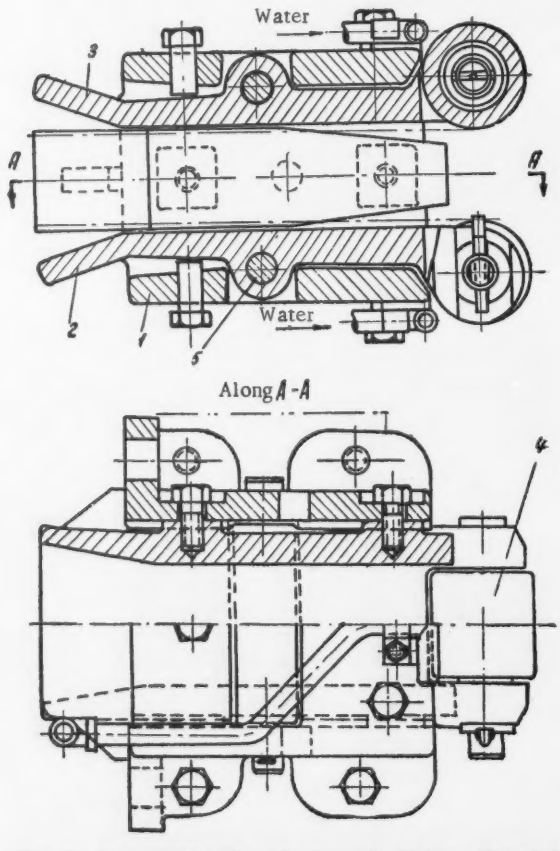


Fig. 6. Entry guides of vertical stand: 1) box; 2) and 3) guide plates (right and left); 4) roller; 5) axles.

An improvement in the wear resistance of roller guides can be achieved by improving the durability of their main parts, i.e., rollers. Development work in this direction is under way at several works.

Rollers made of gray and alloy cast iron with a sorbitized surface as well as rollers made of low and medium-carbon steel with the surface built up with TsI-1M, TsS-1 and TsS-2 (sormite) electrodes have the highest durability. These rollers can be reconditioned by building up the surface directly at the shop. Reconditioning of the rollers with hard alloys is cheaper than making new rollers.

For an improved quality of the surface of the stock and a better accuracy of rolling, roller guides are at present installed not only on the finishing and prefinishing stands but also at the intermediate and roughing stands of the rolling mills. Examples in this field are the practice of the 300 medium-section mill of the Magnitogorsk Metallurgical Combine and of the 300 continuous section mill of the Chelyabinsk Works and the 350 mill of the Makeevka Works. Of special importance are roller guides on intermediate and finishing stands of mills which roll nonferrous metals and alloys which are very susceptible to surface scratches.

The manufacture and installation of new rolling mills require roller guides which can operate at a speed of 20 m/sec or more. In the development of the design of these guides special attention should be paid to the bearings of the rollers which now operate at maximum permissible speeds. It is essential to use bearings which are well protected from the ingress of water and scale.

The tendency to reduce the time required for guide adjustment after the roll change or pass change as much as possible resulted in the appearance of new methods of mounting guides in the stands. Figure 4 shows the mounting of guides on a block which can swing aside. The block is fixed in the working position by means of a catch, a pin and a cotter. During the roll change the guides need not be removed from the block and thus the time required for the adjustment is considerably reduced. This construction has been used at a section mill designed in Czechoslovakia.

Another design of the block permits a displacement of the guides during the roll change without affecting the positioning and the adjustment of the guides. This reduces the time required for the adjustment of the stands of multistrand continuous mills, section mills in train and wire mills.

The majority of the newly designed and manufactured continuous billet and section mills have stands with vertical rolls. Experience on the operation of the 850/700/500 mill at the Anshan Metallurgical Combine in China shows that since rolled pieces of large cross section are not turned at these mills, it is possible to use sliding guides on all stands of the mill without impairing the quality of the surface. Figure 5 shows the installation of guides on the stands of the 700/500 billet mill which is being built at the steel works in Bhilai (India). The delivery guides of the horizontal and vertical stands of this mill have no guide shoes. They are replaced by specially designed guide trumpets which can be easily opened if the rolled piece jams.

The vertical stands of new section mills are provided with roller guides. The design of these guides is similar to the design of the guides for horizontal stands (Fig. 6).

The existing roller guides of the finishing stands at light-section and wire mills have somewhat larger dimensions than the sliding guides, because of the specific features of the roller guide design and the size of the rollers themselves. Therefore, at multistrand light-section and wire mills, sliding entry guides are used in order to make a better use of the whole length of the roll barrel. At the same time the durability of the entry guides can be increased by a factor of 7.5 to 13.5 by chromium or boron treatment of their working surfaces.

During multistrand rolling at the 250 wire mill of the Beloretsk Metallurgical Combine, guides with inserts made of VK-6 and VK-8 hard alloys are used.

Experience has shown that at large metallurgical works which have a large number of mills, it is desirable to have a small shop for the manufacture and maintenance of guides. Such a shop should have forging, iron-casting and welding sections as well as the necessary equipment for machining guide parts.

For the equipment of new rolling mills with modern guides and a complete replacement of obsolete guides it is necessary to establish a specialized works for the production of guides, on the lines of the works which produce working rolls. The study of advanced techniques and a close cooperation between the personnel of such a works with the users will make it possible to improve the design of mill guides continuously.

In the solution of the problem of a centralized supply of mill guides designed on the basis of advanced experience and manufactured under the conditions existing at modern machine-building works, the experience of advanced countries, in particular the USA and Sweden, should be taken into account.

* * *

THE PRODUCTION OF BALL-BEARING STEEL

V. F. Isupov

A. K. Serov Metallurgical Combine
Translated from Metallurg, No. 3, pp. 22-24, March, 1960

The melting of ball-bearing steel was carried out for the first time in 1932 in an electric furnace at the "Elektrostal'" Works.

In 1938, at the A. K. Serov Metallurgical Combine, the ball-bearing steel was melted in an acid open-hearth furnace and the production of rolled ball-bearing steel was started. The production process consists of the following operations: the delivery of the semiproduct from the section mill (the end rods are made into a separate batch); oxidizing ("rough") annealing of the semiproduct; the inspection of the semiproduct after the rough annealing and tests on microstructure, hardness and decarbonization; descaling of the semiproduct in a rotary drum; straightening of the semiproduct on a roller-straightening machine; sharpening on cutting machines; pickling in a sulfuric acid solution; removal of surface defects (only from the end rods; middle rods are not subjected to dressing); pickling after dressing; drawing; straightening after drawing; recrystallization ("bright") annealing of the rolled steel in tubes; hardness, microstructure and decarbonization tests on the rolled steel after the bright annealing; straightening on the roller-straightening machines; sorting on a magnetic defectoscope; end cutting; spark testing; packing; weighing; storing; loading into rail cars.

The semiproduct is delivered to the rolling shops after preliminary sorting. Until this time its surface is still unsatisfactory (there are some surface defects and the decarbonized layer) which creates considerable difficulties in the production of this steel.

For an improvement in the quality of the semiproduct, several investigations have been carried out as a result of which the following conclusions have been established:

1) The most frequently occurring surface defects in the form of folds, seams, and small cracks are caused mainly by rolling with worn-out steel rolls on the breakdown stand of the 320 mill. An attempt was made to use cast-iron rolls but the results were unsatisfactory because the rolls fractured easily. Rolls made of chilled cast iron, modified with magnesium, were found to be quite durable. When these rolls replaced the steel rolls in the breakdown stand of the 320 mill, the surface of the semiproduct improved considerably.

2) The end rods of the rolled piece have the most unsatisfactory surface. Therefore they are collected into separate batches and after pickling they are carefully sorted and dressed.

3) The heating regime of the billets before rolling is as follows: The temperature at the delivery door of the furnace is not more than 700 deg. C., at the beginning of the heating zone not more than 900 deg. C; the time for heating the billet at a furnace temperature above 900 deg C is not more than 30 minutes; the furnace contains an oxidizing atmosphere (the content of free oxygen in the flue gases constitutes 5-7%).

This heating regime of billets ensures such a small decarbonization of the semiproducts that no check on the decarbonization is now conducted.

Operating the new method it was possible for the Combine to reduce the amount of work done on dressing the semiproducts by a factor of 4 and to increase the output of rolled ball-bearing steel by 30-35%.

However, even now, during the sorting of rolled products one still finds about 10-15% of the rods with surface defects.

Black (oxidizing) annealing is carried out by heating the semiproduct to a temperature above the critical point Ac_1 and takes a very short time (Fig. 1.).

Annealing furnaces with a movable hearth which were used previously had a serious disadvantage. The steel in the charge was heated very slowly over its cross section. There were 30-32 hours required to achieve a completely uniform temperature of the whole charge. For speeding up the heating, the combustion gases from three burners were diverted underneath the charge, and from two burners only to the top of the charge. As a result it was possible to reduce the time of metal heating to 8 hours.

The recrystallization ("bright") annealing in tubes is also distinguished at our Combine by its very short duration; it takes in fact 12 hours (23 hours at the "Krasnyi Oktyabr'" Works, 18 hours at the Zlatoust Metallurgical Works). A reduction in the time of bright annealing was achieved by using a higher annealing temperature than at other works (Fig. 2).

At present, tests are being made on bright annealing without tubes. A number of batches were annealed under the operating conditions indicated in Fig. 3. Quite satisfactory results were obtained; the hardness, microstructure and decarbonization were within the limits required by standard specifications. Scale is removed from the rod surface by pickling.

During the black annealing a fairly thick layer of scale is formed and this is difficult to remove by pickling and is not removed uniformly.

At our Combine a revolving drum of 2-ton capacity, in which the scale is fully removed mechanically from the surface and hence the time of pickling is reduced several times over, has been installed for the first time.

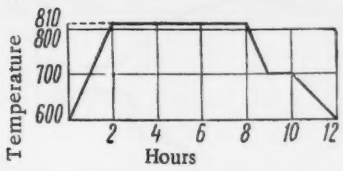


Fig. 1. Temperature regime during the black annealing of ball-bearing steel.

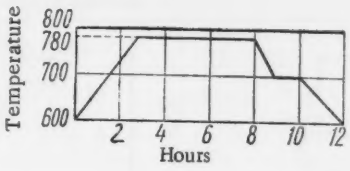


Fig. 2. Temperature regime during the bright (recrystallization) annealing of ball-bearing steel in tubes.

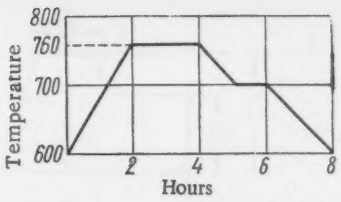


Fig. 3. Temperature regime during the open (without tubes) recrystallization annealing of ball-bearing steel.

The Combine has developed and applied new inspection methods which permit a speeding up of the production process, an improvement in the quality of the product and a reduction in production cost.

A special instrument - a coercimeter - which measures the magnitude of the coercive force in steel, which force depends on the steel microstructure (grain or lamellar pearlite) is used for testing the hardness, microstructure and depth of the decarbonized layer after the black and bright annealings. If the grain pearlite is present the hardness always conforms to the GOST 801-47 specifications.

By measuring the coercive force one can determine, by means of standard specimens prepared in advance, if the quality of the annealing steel conforms to the requirement of the customer.

The use of the coercimeter speeded up the inspection operation on ball-bearing steel by 12-16 hours and reduced the quantity of steel taken for sampling.

The quality of the surface of the rods of rolled ball-bearing steel after the bright annealing is tested with a magnetic defectoscope. In this method the rod of rolled steel is magnetized by alternating current and then is lowered into a bath with a magnetic suspension. If the rod has any surface defects, such as fissures, cracks or laps, the ferromagnetic particles of suspension settle on these defects and form a ridge which is easily detected with the naked eye.

Up to 10-15% of the rods with defective surface (small seams, folds, etc.) are detected during the inspection of rolled ball-bearing steel with the magnetic defectoscope. The rods with slight defects are sent to centerless grinding machines. A batch of rods of one size is ground in one operation and at the same time a layer of 0.15-0.20 mm thickness is taken off. Then those rods which still have surface defects are seperated on the magnetic defectoscope. The amount of defective rods constitutes approximately 25-30% of the amount of ground material. The ground rods without defects are checked by the OTK Inspectors and are delivered to the customer, or are returned to be drawn again and then are not subject to the check by the OTK Inspectors.

The ground rods which still have surface defects are reground again and tested with the magnetic defectoscope.

In general the rods with deep surface defects are reground three times. Rods which still have defects after the third grinding are classified as second-grade. They constitute approximately 5% of the total ground steel or less than 1% of the total production of rolled ball-bearing steel.

* * *

THE ROLLING OF PS-107A SECTION FROM ALLOY STEEL

M. V. Shuralev and S. G. Nekrasov

Zlatoust Metallurgical Works

Translated from Metallurg, No. 3, pp. 24-26, March, 1960

The production of a new reduced-weight section PS-107A, which is a T-beam with a thick flange and a low web (Fig. 1), from 1Kh18N9T and ÉI481 steels has been introduced at our Works.

The section is rolled from a square billet of 85 mm side and 90-100 kg weight on the No.2, 400 mill in 10 passes. The billets are heated in a continuous furnace. The heating regime and the cooling regime of the final product are given in Table 1.

The section is formed from a square billet of 40.5 m side in one oval and three shaped T-passes (Fig. 2a). For a part of the shaping passes we use existing passes intended for rolling usual sections (rounds, squares and flats) produced at the mill.

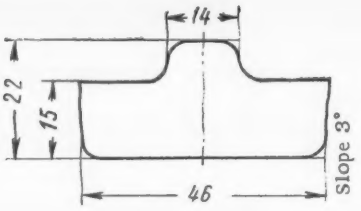


Fig. 1. PS-107A Section.

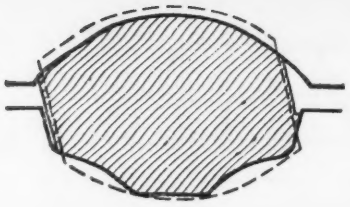


Fig. 3. Diagram showing the formation of the ledge on the sides of the piece when an oblique oval is rolled in Pass 3.

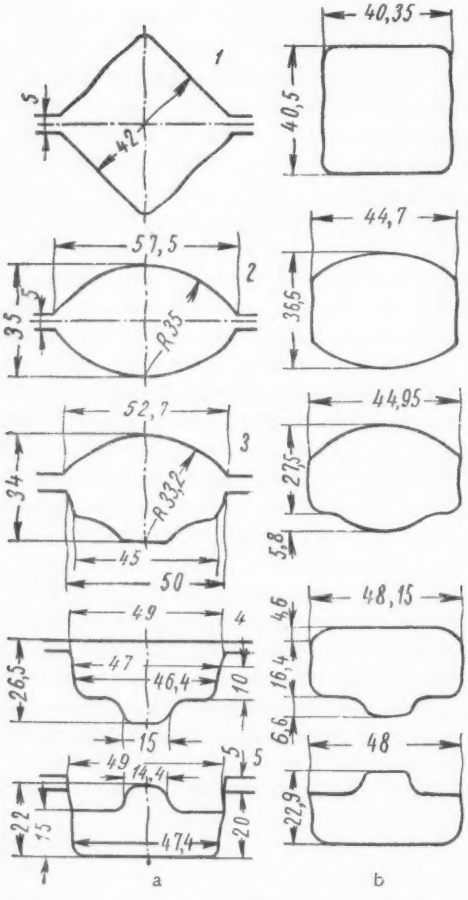


Fig. 2. Pass design (a) and templets (b) for rolling PS-107A section.

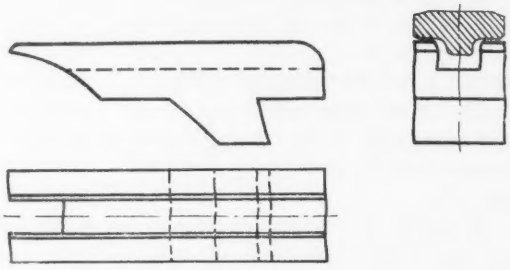


Fig. 4. Fork-shaped grooved guide.

TABLE 1. Heating and Cooling the PS-107A section

Steel	Temperature of heating °C	Time of heating, hr-min	Cooling
1Kh18N9T	1170—1200	1—40	Stacked, in air
ÉI481	1180—1200	2—00	

The square pass, 1, (Fig. 2) is used for rolling rounds of 38-40 mm diameter. The oval pass, 2, is the prefinishing pass for 39-42 mm rounds. The upper portion of Pass 3, is formed from the groove of the prefinishing oval pass used for rolling rounds of 35-38 mm diameter. Pass 4, is a semiclosed T-pass, and Pass 5 (finishing) is a closed T-pass with an opening between the rolls at the upper edges of the flanges. Both these passes are intended only for rolling PS-107A section. Before entering the finishing pass the rolled piece is turned through 180 deg. Pass 1 is in the first stand, Passes 2 and 3 in the second, and Passes 4 and 5 in the third. The arrangement of the passes was found to be successful since for rolling the above mentioned section it was necessary to make only one new set of rolls for the third stand and to cut one groove on the existing lower roll of the second stand (for Pass 3). All this reduced the roll stock to a minimum, simplified the manufacture of rolls, and eliminated time losses connected with roll changes in the first and the second stands of the mill. For the rolling of PS-107A section it is only neces-

TABLE 2. Pass arrangement for Rolling PS-107A Section.

Stand	Pass No.	Groove shape	Pass dimensions, mm			Dimensions of the rolled piece, mm			Cross section area of the rolled piece	Draft co-efficient	Angle of grip	Groove No.
			height H	width, B	side of square pass, A	height H	width, B	side of square pass, A				
	Billet		—	—	—	—	—	85	7100	—	—	—
I	1	square	—	—	78.5	—	—	77	5830	1.22	21°10′	—
	2	square	—	—	70.4	—	—	69	4630	1.26	25°15′	—
	3	diamond	70	100	—	68	88	—	3750	1.24	23 06′	—
	4	square	—	—	55	—	—	53.5	2820	1.31	18°30′	—
	5	diamond	52	82	—	49.5	80	—	1950	1.44	20°30′	—
	6	square	—	—	42	—	—	40.5	1630	1.19	22°30′	1
II	7	Oval	35	57.5	—	37	45	—	1410	1.16	13°15′	1
	8	Shaped	34	52.7	—	34	47	—	1250	1.13	7°20′	3
III	9	Shaped	26.5	49	—	26.5	47	—	970	1.29	11°25′	4
	10	Shaped	22	49	—	22	48	—	822	1.18	8°40′	5

sary to change the rolls in the third stand. The convex top of Pass 3 prevents the metal from being spread into the opening between the rolls and also helps in the formation of the web. The semiclosed form of Pass 4 made by the groove in one roll only and by a smooth second roll, permits a good alignment of the web relative to the flanges and facilitates the adjustment of the rolls.

The rolling of an experimental and then commercial consignment of PS-107A sections showed that for a correct filling of the section the shape of the initial square and the accuracy in the adjustment of the oval pass, 2, are of great importance. If the adjustment is not accurate or the diagonals of the square are not equal, the piece turns in the oval pass and an irregular oval is formed. When such an oval is rolled in Pass 3, fins are formed on the sides of the rolled piece and they may result in lap-formation in the subsequent passes (Fig. 3). If the mill is adjusted properly all parts of the section are fully filled. To check how the intermediate passes are filled during the rolling of the 1Kh18N9T steel we took samples from the rolled piece after each pass (Fig. 2b).

Table 2 gives the data on the rolling of PS-107A section.

In Pass 4 the piece tends to jam in the groove of the middle roll and there is a danger of the piece wrapping round the roll. To prevent this, we installed in the pass a steel fork-shaped grooved guide (Fig. 4) which rests with two "arms" on the roll; the section leaving the pass rests with its flanges on the guide. Experience has shown that this design of the guide ensures a satisfactory delivery of the piece from the rolls.

In the finishing pass the piece jams in the lower groove and bends around the lower roll. To prevent the piece from wrapping around the lower roll, we used an ordinary flat guide.

The temperature conditions are of great importance during the rolling of PS-107A section as well as other sections of alloy steel. With a decrease in temperature the resistance to deformation of the two steels (especially EI481 steel) increases rapidly and so does the pressure of the steel against the rolls and, therefore, the rolling process should be completed at as high a temperature as possible (not less than 950° C).

PS-107A section is now used instead of a rectangular section manufactured previously. The use of this new section saves 25 to 35% of expensive metal, which was machined off and wasted at machine building works, and considerably reduces the amount of work required for machining during the manufacture of steel parts.

* * *

THE INTRODUCTION OF A NEW SECTION FOR THE CAR WHEEL RIM

B. M. Ilyukovich

Senior Roll Designer at the Chusovsk Metallurgical Works

Translated from Metallurg, No. 3, pp. 27-29, March, 1960

The 550 mill at our Works should specialize in rolling small shaped sections for the car industry, agriculture and other branches of industry. In this connection a modernization of the mill has been started. The obsolescent steam engine of the main mill train has been replaced by an electric motor of 1720 kw; a mechanized cooler, conveyors for scrap removal and a scraper hoist for scale disposal have been installed and a centralized lubrication system has been introduced.

Unlike most of the sections for the same purpose, the new reduced-weight section for the wheels of the ZIL-157 truck has no locking part for mounting the locking and the flange rings, and it can be rolled in the finishing pass without bending the base of the section. Therefore, the difficult operation of straightening the section base on special machines at car factories is eliminated and hence the production cost is significantly reduced.

The dimensions and tolerances of the finished section are given in Fig. 1. In the design of the passes an open type of pass was accepted and this ensures constant dimensions of the section during the rolling process, easy adjustment of the mill, satisfactory reconditioning of the rolls to the required original dimensions, and a low consumption of rolls.

For the prevention of the displacement of rolls during the rolling, the projection of the right and left portions of the open passes on the vertical axis should be equal or only very slightly different. In order that the end part is well filled one can allow a difference in the projections in the passes in which the initial formation of the sections takes place.

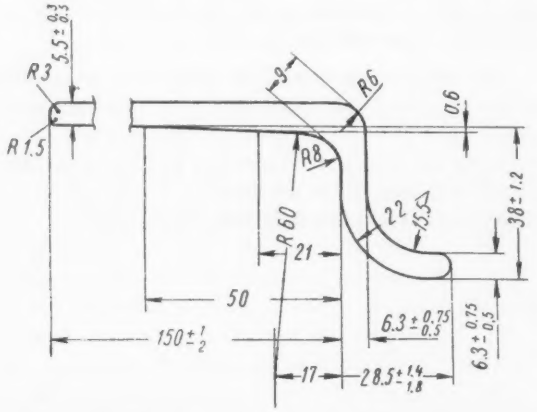


Fig. 1. Dimensions and tolerances of the wheel rim for the ZIL-157 car.

Figure 2 shows the dimensions of the pass templets for rolling the new wheel rim.

After a trial rolling during which some deviations from the calculated dimensions were observed, the reductions of the end part in the 7th pass were increased. Here, the base was subjected to the highest draft and since the steel mass in the end part prevented elongation after leaving the rolls the base of the ring had a waviness which was partly enhanced by the nonsymmetrical contour of the section. Because of this waviness the width of the base was found to vary in the 7th pass if the prefinishing pass was not completely filled. However, the variation in the width of the section did not exceed the specified tolerances.

The finishing pass, where in addition to deformation the section is also straightened, is designed in such a way that the vertical projections of both parts of the sections are equal, so that a displacement of rolls during rolling is prevented. The base is inclined at 15 deg to the horizontal axis. This arrangement of the finishing pass ensures the rolling of the piece within the allowed tolerances but it has some disadvantages. In the working position the opening between the upper and lower roll at the end of the section base goes up to 1.5 mm and it is difficult to obtain a sharp corner in the roll opening. Therefore, the finished section is rounded, with a radius of curvature up to 3 mm.

In the roughing passes the inclination angle of the base varies within 20-35 deg and decreases gradually as the rolling proceeds.

The width of the passes was determined from the center line of the section, taking into account the spread, and then the templets were superimposed and the width corrected accordingly. The double check was necessitated by the complicated process of shaping in open passes where, in addition to deformation, a displacement of the piece relative to the pass and an upsetting at the junction of the end part with the base take place. The curvatures are selected to suit the design.

In the prefinishing pass the end part is made slightly thicker so that it is possible to adjust the length of this part of the finished section by means of reduction.

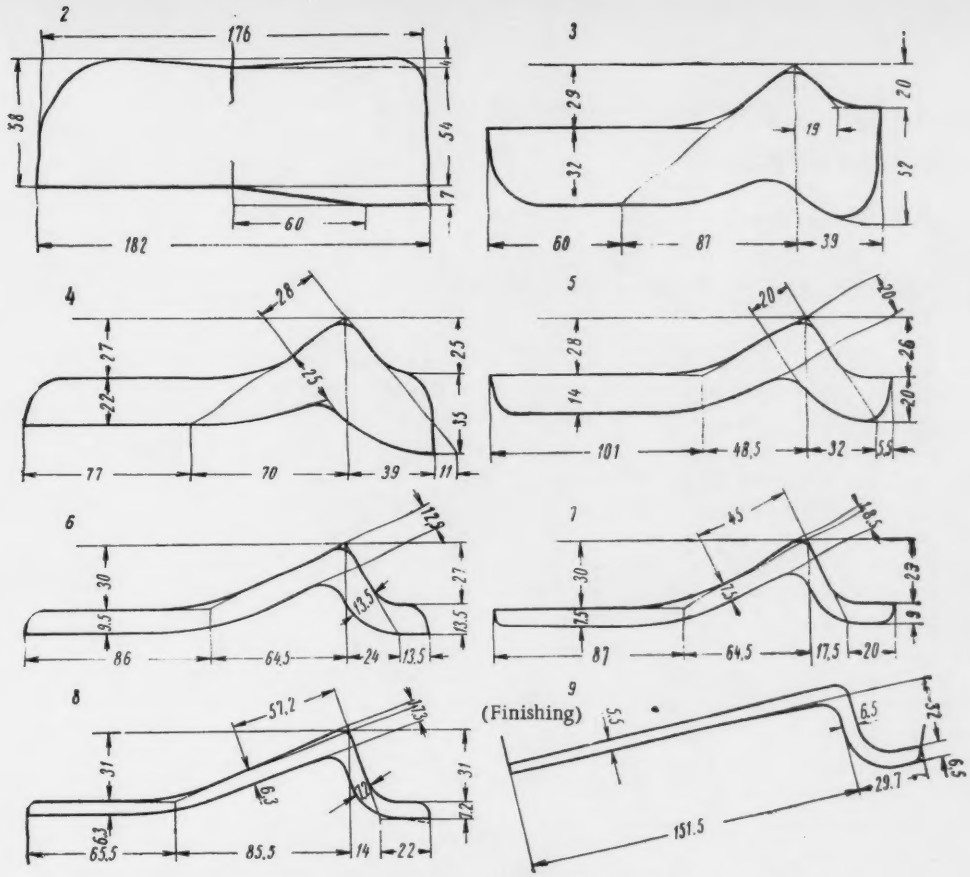


Fig. 2. Dimensions of pass templets for rolling the wheel rim for the ZIL-157 car.

The selection of the billet was based on the available material from the billet mill. The 112 x 148 mm billet, designated for the production of the wheel rim for the GAZ-51 cars, was found most suitable for the purpose. The width of the billet was not adequate and, therefore, the required spread was provided for in the first two box passes of the 550 mill.

The design of the guides for open passes is simple and consists of delivery guides and entry guides or boxes mounted on guide blocks. Entry guides are installed only in the finishing pass and with the use of these guides it is possible to adjust the dimensions of the final section slightly.

On the breakdown stand, which has four passes, there are cast-iron entry tables instead of guides, at the front and rear sides of the mill. The gap between the entry tables and the rolls should be as small as possible (8-12 mm) since otherwise during rolling in the third and fourth passes a partial shearing of the side wall of the end part takes place as a result of displacement and this makes the entry of the piece into the next pass rather difficult.

During the introduction of this section into production the length of the base after the fourth pass was greater than necessary and, therefore, in the fifth pass a thin metal ridge formed on the side wall over the whole length slightly below the opening between the rolls.

In the subsequent pass the ridge was not rolled out because of large curvatures; it cooled down rapidly and fractured if the reduction was difficult. The finished product had scabs which later were eliminated by some adjustment of the rolls in the breakdown stand.

For the entry of the piece into the three-high roughing stand which has no lifting and tilting tables, there are two inclined troughs, in the form of truncated equilateral triangles, between the middle and upper rolls. The narrow end of the trough faces the entry boxes mounted on the guide block at an angle to the passes. In order that the rolled piece passes freely to the back of the stand, i.e., between the lower and the middle roll, hinged baffle plates adjoin the trough so that the entry of the section can be mechanized at little cost.

The gripping of the rolled piece between the steel rolls of the breakdown stand was improved by ragging the bottom of the grooves with a toothed roller. No surface defects on the finished section were detected.

The dimensions of the finished section obtained from the first trial rolling conformed with the permissible tolerances and technical specifications.

* * *

THE TECHNIQUE OF METAL CUTTING WITH CIRCULAR SHEERS

L. V. Shchepnina

VNIIMETMASh

Translated from Metallurg, No. 3, pp. 29-31, March, 1960

A cut in a steel plate is considered satisfactory if the cut edge is even, perpendicular to the plate plane without fins and roughness. If the plate is not cut properly the edge may become bent, or cracked, the cutting surface may become uneven and the plate may become curved. The edge bends most frequently when very plastic metal or plates of less than 0.5 mm thickness are cut. The causes of this phenomenon are: a) the knives have an overlap or have a side gap between them larger than the nominal one; b) plate which is less than 0.5 mm thick is cut with knives of a diameter larger than the nominal one; c) the knives are blunt.

Cracks occur on the cut edge most frequently during the cutting of a brittle metal if: a) the overlap of the knives is larger and the side gap is greater than the nominal, and b) the knives are blunt.

The cut is uneven when: a) the overlap of the knives is smaller than the nominal one; b) the gap between the shears is larger than the nominal one; c) the shears are blunt.

The strip becomes curved if a narrow strip is cut with knives which have an overlap or a lateral gap larger than the nominal one for cutting narrow strips.

Therefore, to obtain a satisfactory cut one must adjust the knives properly, that is establish a correct vertical overlap and a correct lateral gap. In addition, the appearance of the cut is affected by the angle at which the knives are ground, the lubrication, the bluntness of the knives, etc.

On studying characteristics of disc shears at various works in the USSR we found that the overlap varies within the limits of minus 5 to plus 10 mm.

At the Magnitogorsk Metallurgical Combine plates of 15-25 mm thickness are cut with knives set with a negative overlap (Fig. 1a). However, when the overlap was set at minus 4 mm the cut edge of a 20 mm plate was uneven. At the Makeevka Metallurgical Works, plates of 3-10 mm thickness are cut with knives set with a positive overlap of up to plus 10 mm (Fig. 1b). The cutting of 8 mm hot plate with these knives set at a plus 10 mm overlap was unsatisfactory (a bent edge and fins). When investigations were made into the cutting process of 0.1-10 mm thick strips from steels St.3, 1Kh18N9T and ÉI654, aluminum, duraluminum and titanium with knives 170 and 270 mm in diameter it was found that the edges begin to split at certain overlaps depending on the thickness and mechanical properties of the metal being cut. For 3-10 mm thick plates these overlaps are negative, for 0.5-2 mm thick plates the overlap is equal to zero and for 0.5 mm thick strips the overlap is positive. Thus, for instance, when a 0.1 mm thick plate of 1Kh18N9T steel was cut with knives set at +0.5 mm overlap the edges did not split. When the overlap of the knives was reduced (if it was negative) or increased (if it was zero or positive) the edge was uneven at the beginning of the cut followed by a clear cleavage zone which decreased if the overlap was increased. On the other hand, the distortion zone increased. With plus 1 to 3 mm overlap and a side gap between the knives of 0-0.05 mm the cut face consists of an 80 to 90% area of cleavage zone and a 10-20% area of distortion zone. When the overlap is more than +5 mm the cut edge of plastic metals becomes bent and the edge of brittle metals has cracks as well as fins and the whole plate becomes curved. These effects increase with an increasing overlap of the knives.

In the course of the cutting process the knives blunt quickly, the quality of the cut deteriorates and fins appear. When the knives are very blunt the edge of the plate is bent or exhibits cracks depending on the plasticity of the metal being cut. Tests have shown that when the knives are only slightly blunted, the quality of the cut is improved if the overlap is increased. Therefore, sharp knives should be set at a minimum overlap, within the range of

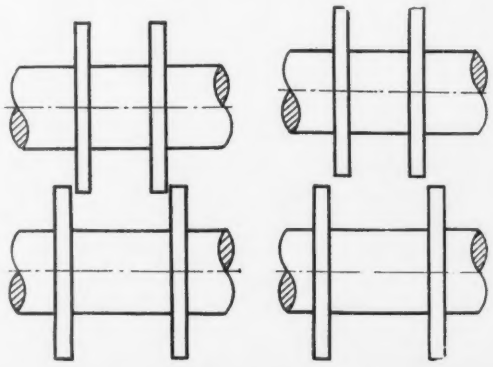


Fig. 1. Diagram showing the setting of the knives.

+0.5 to +1.0 mm depending on the thickness and mechanical properties of the metal to be cut. As the knives become blunted the overlap should be increased to between +3 and +5 mm.

For a good quality cut on 15-25 mm thick plates of very plastic or brittle metals when sharp knives are used, it is recommended to set the knives at a negative overlap of up to 3-5 mm. As the knives become blunted the overlap should be reduced to 0-1 mm. For cutting thinner plates it is not recommended to apply a negative overlap because its value should be accurately selected depending on the diameter of the knives, the thickness and mechanical properties of the plate being cut; a small increase in the overlap may result in a deterioration of the cut (an uneven cut) or the knives may fail to cut the plate. In addition, the design of the majority of shears does not permit operation with a negative overlap because the shafts may be displaced laterally and the knives may fail to cut the plate.

A satisfactory cut obtained by an accurately selected negative overlap (a smooth cleavage zone) can also be achieved by the careful selection of the lateral gap between the knives, the angle of grinding and the lubrication. It was found during the investigations that with an increasing lateral gap the distortion zone decreases and the cleavage zone increases. At certain magnitudes of the lateral gap and depending on the thickness and mechanical properties of the metal to be cut a smooth cleavage zone is obtained. However, a further increase in the gap causes the formation of fins, an uneven cut, a bent edge, curvature of the plate and, finally, the knives fail to cut the plate. A good quality cut was obtained with the following values of the lateral gap:

Plate thickness, mm	Gap, mm
Up to 0.2	0—0.05
0.2—0.5	0—0.1
0.5—2	0.05—0.3
2—4	0.1—0.4
4—10	0.1—0.7

The play of the circular knives should be within the above limits.

In addition, it was established that as the knives become blunted the cut improves if the lateral gap is reduced. Since the design of the shears does not permit a quick adjustment of the gap between the knives, it is necessary to set the knives with the nominal gap between them. At the same time, for cutting plastic metal the nominal gap should be near the minimum value, and for cutting brittle metal the nominal gap should be near the maximum value.

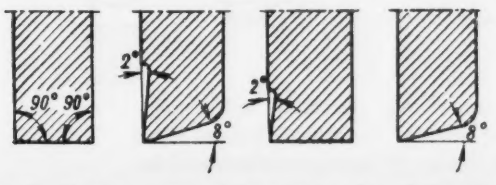


Fig. 2. Various angles of the cutting edge of the knives.

At Soviet works the knives are set with a gap between them of 0-3 mm. The use of 1 mm lateral gap at the Makeevka Works is due to the fact that the knives operate with up to 10 mm vertical overlap. However, as was indicated above, the quality of the cut is poor. It is interesting to compare the values of the lateral gaps between the knives during the cutting of thick plates (5-25 mm). At the majority of works the lateral gap between the knives is 0.1 to 0.3 mm, and at the Nizhne-Tagil Metallurgical Combine the gap is up to 3 mm. With large lateral gaps (1.0-3.0 mm) the quality of the cut was poor.

In the main, the knives have a rectangular cutting edge. It was established on the basis of the investigations that the quality of the cut improves if the cutting edge of the knives is ground to an angle smaller than 90 deg (Fig. 2). Thus, the cut face of a 4 mm thick plate of duraluminum D16AT had uneven, flattened out portions which decreased or increased depending on the setting of the knives, but could not be eliminated completely.

When the knives were ground to the shape shown in Fig. 2 (second from left) the cut had an even cleavage zone. The cut in other metals, except aluminum, constituted a clear cleavage zone when the overlap of the knives was +1 mm and there was no lateral gap between the knives. Knives with a cutting edge ground to less then 90 deg are not widely used because of the difficulties of manufacture. It is, however, recommended that such knives should be used when cutting plates of up to 1.0 mm thickness in order to obtain a satisfactory cut. For a longer service life of knives lubrication is essential. Machine oil is most suitable for the purpose. It was found from experience at the Moscow Tube Works that the lubrication of knives during the cutting of scale-covered hot-rolled plates increased their service life by 3-4 times. In addition, lubrication improves the quality of the cut; fins decrease or even disappear completely and the cleavage zone increases.

At some works, the shears fail to operate because, due to the crescent shape of the plate, the plate edge is sheared and jams in the guides.

Tests have shown that properly set knives correct the crescent shape of the plate. If during the cutting operation one employs vertical front guides, the shape is not corrected, but if rear guides are employed the crescent shape is corrected. Therefore, in order to eliminate the shearing of the edges one should employ vertical front guides, and the strip should move freely to allow for adjustments. Free movement of the strip can be achieved by the formation of a loop in front and behind the shears.

To correct the crescent shape of the plates one should employ vertical rear guides.

* * *

A MECHANIZED CHANGE OF THE BEARINGS OF THE UPPER ROLL

V. G. Attaryan

Mechanic of the Tube-Billet Mill at the Zakavkaz Metallurgical Works

Translated from Metallurg, No. 3, pp. 31-32, March, 1960

The dismantling and assembly of upper-roll bearings during the overhaul of the working stand of the blooming mill are carried out in the following way. After the removal of the rolls a scaffolding made of sleepers is erected under each bearing, and the bearings are detached from the housing screws which are then lifted and taken out of the seat in the bearing; the bearing is then attached to a crane and moved on the scaffolding, first inside the stand and then to one side, and out. This operation is very arduous: The massive bearing weighing up to 5 tons has to be taken up several times and pushed with iron bars since it is inside the closed stand and cannot be removed by being lifted vertically or pulled down directly (Fig. 1a); in addition, during the whole period while the bearings are being dismantled and installed, the crane cannot be used for any other work.

On the suggestion of the author, a special attachment, which permits the roll-change mechanism to be used for the dismantling and assembly of bearings, has been employed at the 900 tube-billet mill. After the roll removal the attachment, which consists of channel sections welded into a frame on top of which there is a turning mechanism mounted on a large-diameter thrust bearing, is placed on the roll-change mechanism (Fig. 1b). The attachment together with the roll-change mechanism is moved forward until the turning mechanism comes under the first bearing; the bearing is lowered onto the turning mechanism with the use of the screw-down mechanism; the screw of the screw-down mechanism is disengaged and taken out from under the bearing. The bearing, together with the attachment, is then moved inside the stand, turned through 90 deg (Fig. 1c), taken outside the stand and lifted freely from the attachment by the crane. The bearing can be easily moved through 90 deg by hand; in this position the head with the bearing is fixed by a stop pin. The second bearing is dismantled in the same way. The assembly of the bearing is carried out in the reverse order.

The use of the attachment reduced by half to two thirds the time required for changing the bearings; it almost eliminated the use of the crane which is of great importance during repairs to rolling mills, and made the work much easier and safer.

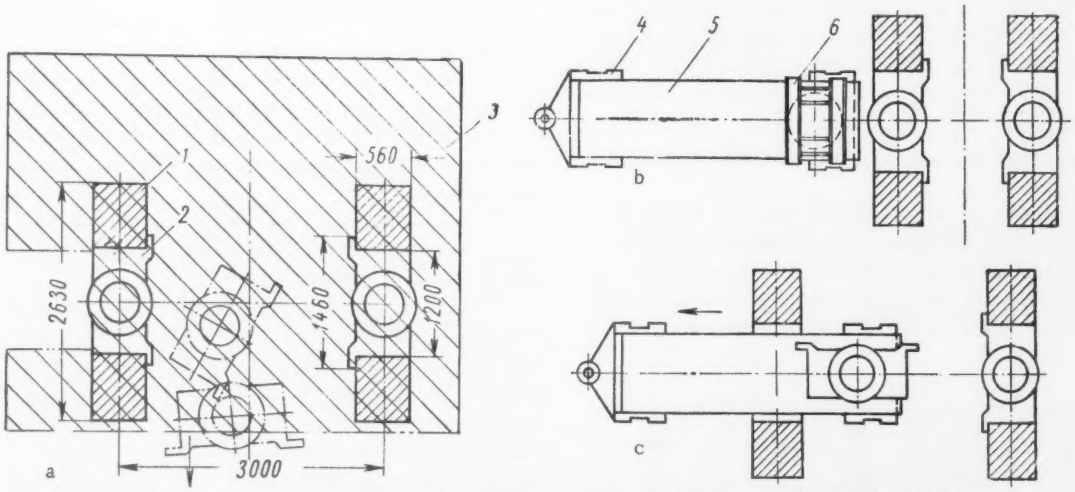


Fig. 1. The removal of upper-roll bearings by means of the roll-change mechanism and turning mechanism. 1) frame of the 900 working stand; 2) upper roll bearing; 3) covered platform above the working stand; 4) box of the roll-change mechanism; 5) frame; 6) turning mechanism of the attachment.

* * *

THE MODERNIZATION OF SHOCK ABSORBERS OF LONG-STROKE CYLINDERS OF PIERCING AND ROLLING MILLS

A. F. Krisanov

Shop Head's Assistant in charge of equipment at the Nikopol Yuzhnotrubnoi Works

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The output of piercing and rolling mills of an automatic tube machine depends to a great extent on the speed of approach and delivery of piercing mandrels. This speed, however, is limited by the capacity of the shock absorber to absorb the energy of the moving mass of the carriage, of the thrust bearing and of the piercing mandrel in their extreme positions. The spring shock-absorbers of the thrust bearing carriages on the piercing and rolling mills of the 400 tube-rolling machine at the Nikopol Yuzhnotrubnoi Works have been replaced by air-operated shock absorbers with individual air supply lines (see diagram). The absorber rod with the piston is rigidly mounted on the frame by means of a collar and a cotter. Compressed air from the lines is fed into the working space of the absorber through a reversible ball valve with a spring whose pressure on the ball can be adjusted by a screw. In this way one can control the air pressure in the working space of the shock absorber.

When the carriage strikes against the shock absorber the cylinder moves on the stationary piston, and the energy of the shock is absorbed by the compressed air.

Calculations show that the maximum energy which can be absorbed by a pneumatic shock absorber is 2.5 times greater than the energy absorbed by a spring shock absorber of the same size. In addition, the maintenance of pneumatic absorbers costs less.

With the adoption of pneumatic absorbers at the 400 tube mill the consumption of thrust bearings decreased and the output of the mills increased.

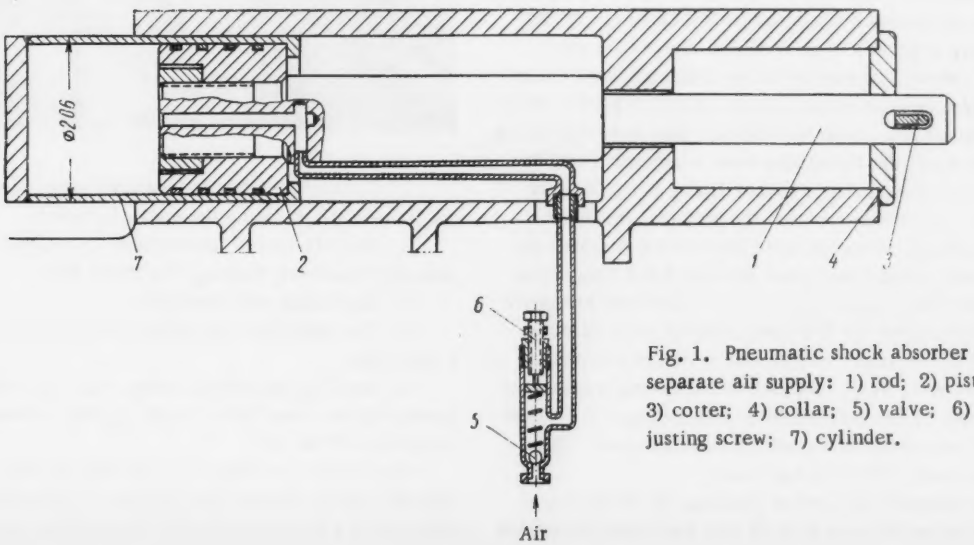


Fig. 1. Pneumatic shock absorber with separate air supply: 1) rod; 2) piston; 3) cotter; 4) collar; 5) valve; 6) adjusting screw; 7) cylinder.

* * *

LINING TUBES WITH RUBBER

M. S. Goncharevskii and Ya. N. Lipkin

Ukrainian Tube Research Institute
Translated from Metallurg, No. 3, pp. 33-34, March, 1960

With the development of the chemical industry the problem of the prevention of corrosion of industrial tubes became very urgent. Rubber-lined steel tubes are widely used at home and abroad.

The experience of our industry shows that in several corrosive media which do not contain strong oxidizing agents the service life of rubber-lined steel tubes is 2-9 times longer than that of stainless steel, 1.5-3.5 times longer than vinyl plastics and 2-7 times longer than faolite. The advantages of using rubber-lined steel tubes are even higher for corrosive substances containing hard particles (acid solutions with a solid phase in the mining industry, the nonferrous industry the coal-tar industry, etc.), because the rubber lining is much more resistant to erosion than other materials.

Rubber-lined steel tubes can be used for pressures which can be withstood by the steel shell while faolite tubes can only be used for pressures up to 3 atm, and heavy vinyl tubes (maximum outside diameter 82 mm) —up to 6 atm.

Faolite and vinyl tubes are brittle; they cannot stand up to strong hydraulic shock and require outside protection from mechanical damage.

Depending on the medium, the use of vinyl tubes is limited by the temperature (40-60 deg C); rubber-lined tubes can be used at temperatures up to 70 deg C and this temperature limit can be increased to 100 deg C or more when new-type synthetic rubbers are used.

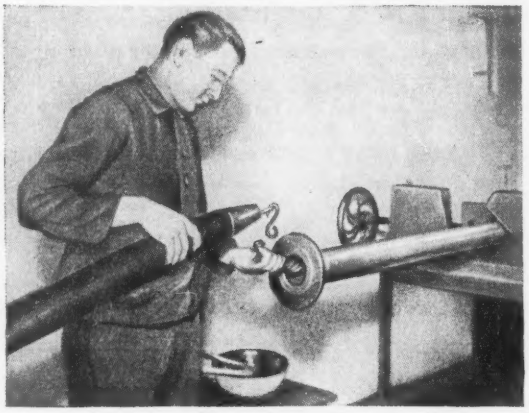
At present, the rubber-lining of tubes is done mainly at the anticorrosion shops of large chemical plants. With small exceptions, crude methods are used in rubber-lining and as a result the lining operation is expensive and the lining is of poor quality. Rubber-lining is 1.5-2 times cheaper if advanced methods are used (at synthetic-rubber plants). However, even if advanced methods are employed, rubber-lined tubes are still 2.5-5 times more expensive than vinyl, and 1.2-1.7 times more expensive than faolite tubes but 2-9 times cheaper than stainless steel tubes. A longer service life of rubber-lined tubes compared with vinyl and faolite has several advantages on account of less maintenance, less stoppages in the operation of equipment and small production losses. This balances their relatively high cost.

For corrosive sections of pipelines in the chemical industry (pipes of more than 82 mm diameter) preference is given to rubber-lined steel tubes even at low pressures.

It has been noticeable in recent years that faolite, vinyl, textolite, stainless steel, lead and copper tubes are being replaced by rubber-lined steel tubes.

There is a fairly high demand for rubber-lined steel tubes in our industry. To meet the demand it is desirable to set up shops or sections for the rubber-lining of tubes and tube fittings directly at tube works.

An analysis of the methods of tube-lining at our plants and at plants in East Germany, Poland, and Czechoslovakia has shown that as a basis for setting up shops for rubber-lining one can take the method proposed by Giprokauchuk, together with the advanced techniques of rubber plants in our country. It is desirable to arrange the process of rubber-lining the internal surface of steel tubes in accordance with the following scheme:



1. Cutting the tubes in measured lengths, welding the flanges and rounding the ends on a lathe.
2. Shot blasting of tube surface to remove scale, and compressed-air blasting to remove dust.
3. Degreasing with benzene.
4. The application of rubber solution by means of a spray gun.
5. Inserting the rubber lining, which is made from double sheets of raw rubber stuck together, corresponding to the size of the tube.

The lining is covered with the solution and inserted into the tube by means of an apparatus consisting of a clamp with a hook connected to a rope from a winch, and a vise to hold the tube in position (see figure).

6. Drying the lined tube to remove the benzene vapor.

7. Pressing the lining against the tube wall by pulling a rubber bulb through the tube by means of a winch.

8. Cutting the ends of the lining and covering the flanges with rubber lining.

9. Vulcanization by steam (3 atm) in a water-cooled vessel by the method used at the Moscow "Kauchuk" Works.

10. Checking the rubber lining by visual inspection, tapping of accessible places with a wooden malet and using a detector.

The method of rubber-lining the internal surface of tube fittings, T-pieces, cross-pieces, bends, 30°, 45° and 60° branch-offs, etc., is similar to the method used for rubber-lining of the internal surface of tubes. The external surface of tubes is lined by wrapping round cut strips of hard rubber, pressing it, and wrapping a double layer of soft rubber strip in the opposite direction.

It is advisable to vulcanize the tubes with rubber lining on the outside in press moulds of the same type used for the rubber-lining of sea structures.

In the Soviet Union, short tubes – up to 1.5 - 2.0 m – are lined at workshops and only at some synthetic rubber plants are tubes of up to 3 m length lined.

The inadequate production of rubber-lined tubes in the Soviet Union is due to the lack of rubber-lining shops, an inadequate study of the problems related to the technique of the application of rubber coating, and the lack of the necessary equipment.

CERAMIC CASTING FOR THE INDUSTRY

V. A. Dorofeev and I. E. Lipovskii

Director; Head of testing and research laboratory
Stalino Ceramic-Casting Works

Translated from Metallurg, No. 3, pp. 35-36, March, 1960

At the end of 1958 the first ceramic-casting plant in the Ukraine was put into production at Stalino. In contrast to the Moscow plant which uses basalt rock, the Stalino plant operation is based on a new charge* which consists of the following components, given in percent:

Burnt rock	70
Dolomite dust	20
Quartz sand	5-10
Chrome-magnesite powder	up to 5

The chemical composition of these components is given in the table.

TABLE 1. Composition of Charge Materials, %

Components	SiO_2	Al_2O_3	$FeO+Fe_2O_3$	CaO	MgO	Losses
Burnt rock	50—54	20—25	9—11	2—4	3—5	5—6
Dolomite	9.8	3.8	2.3	50.2	31.5	2.4
Sand	97.40	0.13	0.39	1.44	0.40	0.24

The chrome-magnesite powder is added to the charge in order to enhance the capability of the melt to crystallize.

All raw materials with the exception of the rock arrive at the plant in the ground state and are not subjected to any processing. The rock is crushed in a jaw crusher before being fed to the process.

Furnaces at the works, which have a capacity of 1-1.2 tons of charge, are heated by coke-oven gas. A cycle lasts 2-2.5 hours and the temperature in the working zone is 1450°.

The finished melt is poured into movable, gas-heated, receiving vessels, from which it is then poured into forms. In the main the plant turns out 185 × 115 × 20 mm lining plates which are cast in heat-resistant steel molds. The molds filled with the melt, are sent to muffle-type coke-oven-gas heated crystallizing furnaces; the temperature of the plates during crystallization is 950-1000°. The plates remain in the crystallization furnace for 7-10 min; thereafter they are knocked out of the molds and sent to conveyor-type annealing furnaces. The latter are of the "lehr" type and are widely used in the glass industry. The annealing lasts up to 14 hrs; finished plates leave at 50-60°.

Pipes, 1200 mm in length, and 150 and 190 mm in diameter, are also made at the plant. Pipes are cast into flanged metallic casings with earthen cores. Crystallization and annealing are conducted in a multichamber furnace. Presently, machines for centrifugally casting pipes are being built.

In addition, thicker lining plates (250 × 250 × 40 mm) are produced at the plant. Presently, the processes for casting ball-mill linings and balls as well as insulators and specially shaped plates (the latter are cast by precision-casting methods) are being developed.

Waste products from the casting process are used during slack periods for production of a filler for chemically resistant cements. These materials are ground in ball mills. Acid-resistance of the powders produced is not lower than 97%.

Stone castings from the Stalino Plant are characterized by the following properties:

1. Specific gravity, g/cm³ 3.08
2. Volumetric weight, g/cm³ 2.8-2.9
3. Acid resistance (according to GOST 475-53), %
   - in sulphuric acid 99.75
   - in hydrochloric acid 99.44
4. Abrasion resistance (on the LKI wheel) g/cm² 0.03-0.04
5. Hardness, on Mohs Scale 8-8.5
6. Mechanical strengths, kg/cm²
   - compression strength 2500
   - bending strength 500
   - tensile strength 150
7. Water absorption, % 0.01

* The charge and the flow sheet were developed by the engineers A. I. Sibilev and N. A. Bukhavtsev together with the authors of this article.

Heat resistance was determined by alternately heating samples to 100° and cooling in water at 18°. Its value is 7-10 cycles.

Chemical composition of the castings is as follows, in percent:

SiO_2	Al_2O_3	CaO	MgO	$FeO+Fe_2O_3$	Na_2O+K_2O
45—49	18—20	10—13	8—10	8—9	2—2.5

Structure of cast ceramic articles is strong and even-grained.

At the Stalino ceramic-casting plant other charges in addition to the one based on burnt rock have been developed; these are generating-station ashes and sand and basalt from the Volnovakh deposit.

High hardness, abrasion resistance, as well as good resistance to acid attack permit the use of ceramic castings in diverse sections of the national economy. Cast ceramic lining plates are used for lining bins, launders, and chutes for transporting ores, agglomerate, coal, coke, crushed stone, sand, lime and other abrasive materials. In addition such plates are used for lining numerous items of chemical apparatus and storage reservoirs.

Plates which are used for wear-resistance are mounted on top of common cement; those used in corrosive media are mounted on top of a paste made from acid resistant powder, liquid glass and sodium fluosilicate.

Cast ceramic pipes may be used for hydraulic and pneumatic transport of hard and abrasive materials, pulps and corrosive liquids.

In practice cast ceramic articles can be used in metallurgical, concentrating and coke-chemical plants. Their use is not solely for linings. It should be advantageous, for example, to construct cast ceramic drum-type screens, wheels and bodies of sand pumps, etc.

Products of the Stalino ceramic-casting plant are already being used at many plants. Accordingly, launders and bins at the New Krivoi Rog Mining and Concentrating Combine are all lined with our plates. Many concentrating plants and coke-chemical works widely use ceramic castings for launder lining. Cast ceramic pipe is used at the Chumak TsOF, Mironivka GES, etc.

In all cases where cast ceramic articles are used in place of metallic ones, the economic effect is extremely large. Equipment service life is increased 5-10 times. Repair expenditures are significantly reduced.

Wide use of cast ceramic articles in the industry will permit the saving of thousands of tons of metal for the national economy.

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METALLURGISTS' CONTRIBUTION TO THE SEVEN-YEAR PLAN ACCOUNT

Ya. L. Granovskii

Instructor at the Central Committee of "VOIR"

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Together with the general productivity upthrust, the engineers, technicians, workers and staff of metallurgical concerns are every day raising the metal output, are improving the process, and are putting into operation new methods and front-ranking technology. Their achievements during the first year of the Seven-year Plan have made it possible to provide in the 1960 operating plan for a greater output of ferrous and nonferrous metals. Accordingly, there are plans to increase the production of pig iron by 9%, steel by 8%, rolled stock by 7%, and pipe by 12%.

A very great contribution to raising the metal output has come from those who are in the forefront of the struggle for technical progress, namely inventors and innovators. The innovator cadres at the metallurgical concerns are assuming increased responsibilities.

Innovators and inventors at the A. K. Serov Metallurgical Combine have committed themselves to achieve, as a result of their programs, a cost reduction amounting to 100 million rubles during the Seven-year Plan. In 1958 at the Combine 1627 inventors and innovators have submitted 2280 proposals out of which 1398 were put into effect with a resultant saving of 10,176,000 rubles. In only seven months of 1959, 1694 innovators have submitted proposals; 1082 were put into effect and a tentative annual saving of 9.5 million rubles resulted.

In the eight months of 1959 the Combine's inventors and innovators have fulfilled the year's commitment and have achieved a 1.5-million-ruble cost reduction on account of 1960. Presently every fifth worker at the Combine is an innovator. As a reward for a very good record of introducing new methods and technology the Red

Ensign of the Sverdlovsk-District Party Committee has been awarded the workers.

The innovators and inventors from the Pervouralsk Pipe Plant have shown particularly noteworthy initiative. They have committed themselves to fulfill the annual innovation assignment before the 42nd anniversary of the October Revolution. The Pevouralsk staff has given assurances that by the end of the year every third worker at the plant will be an innovator; moreover, every engineering and/or technical employee will submit a number of innovating proposals so that the total saving resulting from the latter will not be less than his annual earnings.

High individual obligations for the Seven-year Plan have been assumed by innovator-metallurgists.

One of the complex brigades at the Upper-Isetsk Metallurgical Works, under the direction of the Thermal-Department Supervisor, Comrade Lifshitsin, has submitted a proposal to redesign the electric vacuum furnaces. Putting their proposals into effect enabled them to raise the production capacity of these furnaces and increase transformer-steel output. Savings from the project are about 2.5 million rubles.

The supervisors of the plant's 125 complex innovator brigades have appealed to all innovators of the Sverdlovsk district to start a large-scale campaign to organize complex brigades. They also have committed themselves to mechanize and facilitate operations in many operating departments.

Important work is being done at the plant by the executive of the All-Union Society of Inventors and Innovators (AUSII) (Chairman, Comrade Maslennikov). The executive, together with the management, organizes competitions and reviews on certain subjects in order to promote better innovation work. Progress of the competitions is being regularly published on the innovators' plant bulletin board and in a large-circulation newspaper. Every month the "Satire Window" is published, wherein shortcomings of individual economists, who are holding up the processing, review, and realization of innovators' proposals, are being castigated. The executive organizes trips to other plants for the innovators and inventors, innovators' evenings, and showing of technical films. On recommendation of the AUSII executive active innovators obtain from the Works Management Committee free permits to sanatoriums and rest institutions.

At the Izhevsk Metallurgical Plant the problem of mechanizing the manual operation of removing spools of hot wire from wind-ups at the rolling department was discussed for a long time. After long creative searching, an engineer, Comrade Tverdokhleb, found the technical solution to this problem. The works achieved a saving of 250,000 rubles and the workers got rid of a hard and unpleasant job.

The Plant Manager, Comrade Savelev has himself contributed a very valuable proposal, that of casting elongated steel ingots. He took charge of a complex innovator brigade to put into effect this new method which increases by 20% the productivity of the blooming mill and significantly lowers the expenditures for fuel and electric power and results in a saving of about 2.5 million rubles. The casting of elongated ingots is being introduced at seventeen plants throughout the country.

The metallurgists at Izhevsk achieved an average 30% increase in all indices relating to innovation and invention; 1500 proposals have already been implemented and have given a cost reduction of more than 12 million rubles. The innovators are persistently investigating means of raising labor productivity, are finding additional reserves, and are improving the technology. Accordingly, the complex brigade which includes Comrades Lanin, Drozdov, Babushkin and others has reviewed the operating conditions existing at the Mill-No.-450 furnace and has worked out a new set of operating standards; this has enabled reducing fuel costs by 2 million rubles.

The plant manager has obtained commitments from the shop and department managers to define all bottlenecks, the elimination of which is made a part of "themes." Every theme is being developed by a special innovator brigade.

The plants' innovators have undertaken to achieve, during the current Seven-year Plan, a cost reduction amounting to 125 million rubles and to reduce to a minimum the manual and nonproductive labor as a result of automating and mechanizing the production processes.

Blast-furnace workers at the Magnitogorsk Metallurgical Combine have committed themselves to contribute not less than 20 million rubles to the Seven-year Plan fund. The blast-furnace-department innovators have undertaken to put into effect in 1959 not less than 120 proposals effecting a cost reduction of three million rubles. The blast-furnace workers have organized in their department a communal design office which supplies help to the innovators and inventors. Particularly successful was the complex brigade comprising Comrades Vlasov, Shibeyev, Belikov and others. It developed and successfully put into operation the mechanization of ladle-changing during tapping. Savings as a result of this proposal amount to about one million rubles.

Remarkable process-innovators work at the Stalin Metallurgical Combine at Kuznetskii. These are: mechanics at the sheet-rolling department Comrades Cheremukhin, Churinov; "OTK" Assistant Manager, Comrade Monastirskii; Electric-Furnace-Department Manager, Comrade Glasov; the mechanic at "TsZL", Comrade Vyalov; Senior Railway-Department Foreman, Comrade Krupkin, and many others.

The efforts of inventors and innovators are gaining momentum also at the Kosogorsk Metallurgical Plant. Founder Ksendz proposed to remelt all turnings from threading of fittings in a cupola furnace. This proposal has already saved more than 250,000 rubles.

Innovators at the Nizhne-Tagilsk Metallurgical Combine are devoting a lot of attention to automation. The whole system of automatic dispatching controls in use at the plant has been made and installed by the innovators.

In order to further the growth of technical creativeness of inventors and innovators on a mass scale at the metallurgical concerns, the Union of Metallurgical Industry Employees Central Committee and the "VOIR" Central Committee have on 17th November, 1959 simultaneously taken a decision to hold an inspection of workers' innovations and inventions.

The inspection should attract to the innovators' ranks new hard-working metallurgists. One of its basic indicators should be the number of proposals that have been put into effect. It is regrettable that valuable proposals which are processed through the departments of the Chief Designer, Chief Maintenance Engineer and Chief Power Engineer, are put into effect very, very slowly; this largely because their realization is not being planned as a result of the large volume of current work. Such a situation frequently results in the fact that valuable innovators' proposals are not put into effect for a long time and the state is not realizing hundreds of thousands of rubles of savings which could be possible were new ideas put into effect.

Thus the task of local Unions of metallurgical concern employees and "VOIR" Committees is to organize an educational campaign concerning the inspection, attract to the creative work workers, engineers and technicians of the metallurgical industry, and to introduce close control at all stages of proposal processing.

There is no doubt that our country's metallurgists will be in the first ranks of fighters for technical progress.

A CANADIAN PLANT FOR THE DIRECT REDUCTION OF IRON

G. A. Zyryanov

Council for the Study of Production Forces of the Academy of Sciences of the USSR

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The Canadian company "Quebec South Steel Corporation" has recently announced the proposed construction of a steel plant near Montreal. Construction on the new plant should start in the early part of 1961. The planned capacity of the plant is 91 thousand tons of iron and semi-finished product per year; there will be provision for future expansion. The main raw material will be magnetite ores from the Ironsides Deposit, situated 7 km from Ottawa. The reserves of ores from this deposit with a 47% iron content will provide normal operation of the plant for about 17 years. In addition, ores will be used from the group of deposits at the Big Three Lake (Quebec Province). The reserves of ores from this group of deposits is comparatively small (14-22 million tons). The average iron content in the ore is 40-50%.

It is expected that the plant will operate for 330 days in the year with an average output of 275 tons of metal per day. This plant will be the first on the American continent to use the so-called "Strategic-Udy" process for the direct reduction of iron. An experimental plant working with this process is operating at Niagara Falls. About 10 thousand tons of various ores have been processed in this plant.

At the experimental plant at Niagara Falls there are three triple-phase modernized electrical "Volta" furnaces of 1000 kv-a, a rotating roasting furnace of diameter 1372 mm, length 24.4 m, fitted with a dust trap and ventilation device and operating on gas or oil, and also auxiliary equipment.

In the "Strategic-Udy" process a mixture of iron ore, flux and carbon reducing agent is continuously fed into a rotating furnace in which the materials are dried, the volatiles are removed and the iron is partially reduced from the ore. Depending on the type of ore, the furnace temperature is 1100-1300°. If the temperature system is distributed it is possible to have sintering of the charge and the formation of incrustations on the inner surface of the furnace. To ensure the desired degree of reduction of the iron from the ore the required amount of carbon is introduced into the roasting furnace. In addition, gas obtained in the electrical melting furnace is brought in." The carbon monoxide in the gas is fully used up in the initial stages of the reduction.

To save the thermal and electrical power, the hot mass leading the roasting furnace passes through a special feeder directly into the fusion zone of the electrical furnace. In the electrical furnace the "Strategic-Udy" process is set up on the principle of the so-called open bath ("floating charge"). The height to which the electrode is raised is fixed in dependence on the conditions: from 12.5 cm above the level of the molten slag to 37.5 cm below this level.

In the bath of the furnace, a constant electrical resistance is provided which makes it possible to operate with the maximum power of the furnace.

The carbon reacts comparatively quickly with the iron oxides which were not completely reduced in the roasting furnace. Because of this, good quality metal is obtained from the electrical furnace. The furnace output is fairly high. The metal and slag are tapped periodically from the electrical furnace in the usual way.

The main advantage of the "Strategic-Udy" process is its continuity from the moment the ore is charged until the finished metal is tapped. In this process the mass leaving the roasting furnace is not cooled; this mass does not have to be ground or have magnetic separation, nor is it necessary to sinter the semifinished product obtained from the separators.

A.V. Leskov, Oxygen in Ferrous Metallurgy. Moscow, Gozplanizdat, 1959. 239 pages.

Solving the problems of using gaseous oxygen to intensify processes for producing iron and steel is one of the most important conditions for the further development of ferrous metallurgy in the Soviet Union.

In 1965 oxygen will be used to smelt up to 40% of iron and 70% of steel of the total amount of metal produced.

When analyzing the economic effectiveness of intensifying metallurgical processes it is essential to bear in mind that the use of oxygen in ferrous metallurgy not only increases the smelting but also reduces the cost, improves the quality, cuts labor costs and capital investments in the production of metal; the labor conditions can be improved, cheaper and low-grade fuel can be used.

However, many of these problems have not yet been studied sufficiently. For example, little work has been done on metallurgical units with increased flow of oxygen. In particular, much controversy is caused by the certain amount of reduction in life of the steel-smelting units which occurs in the work. It is therefore essential to carry out a detailed technical and economic analysis of Soviet and foreign experience in using oxygen in ferrous metallurgy.

This work is also important because there is no special literature on the economic effectiveness of using oxygen. To a considerable extent this need has been fulfilled by the book under review.

In the first chapter of this book the author considers the method for determining the economic effectiveness of using oxygen in ferrous metallurgy; he criticizes certain existing methods for calculating effectiveness and gives a number of useful recommendations. This chapter underlines the fact that the metallurgical process should only be intensified by oxygen when the use of oxygen can reduce the cost of the metal.

In the second chapter the author deals with the modern state of the oxygen industry. Having observed that the relatively slow introduction of oxygen into ferrous metallurgy is due to the difficulty of mass producing cheap oxygen, the author deals with the problem of reducing its cost.

The cost of oxygen should be mainly reduced by decreasing the specific consumptions of electrical power (in the production of oxygen the power expenses comprise more than 50% of its cost), wages, reducing the price of electrical power, and also by extracting by-products at the oxygen stations—krypton, argon and nitrogen.

The book rightly mentions the disadvantages in transporting oxygen in cylinders and tanks, and also the undesirability of equipping and using the KT-3600 low output oxygen apparatus. The Seven-year Plan envisages the manufacture of large BR-1 and BR-2 oxygen units with hourly output of 12500 and 35000 m^3 of oxygen respectively.

In the next two chapters the author analyzes the modern state of development in using oxygen for blast-furnace smelting and in steel-smelting processes and he indicates the possibilities of using oxygen in existing blast-furnace and steel-smelting departments and also in steel plants which will be built in the future.

Stating that the solution of the problem of economic suitability of using oxygen in the smelting of conversion iron and blast-furnace ferroalloys is of extreme national importance, the author devotes an important section of the book to the use in blast furnaces of oxygen mixed with natural or coke-oven gas and the use of technical and economic smelting indices under these conditions.

The author also deals with the technical and economic reasons hindering the use of oxygen in blast-furnace production, the chief of which is the expense of the oxygen, the low quality of prepared blast-furnace raw material, etc.

In the chapter on the use of oxygen for intensifying steel-melting processes it is mentioned that at the present time in open-hearth production the most extensive use is made of the method of feeding oxygen in the flame to intensify the combustion of the fuel, which leads to a reduction in the time for the heats by 15-20% and does not have an unfavorable effect on the life of the furnace when the combustion air is enriched with oxygen to the extent of 24-25%. However, this method is less efficient; the cost of steel cannot be reduced when it is used or can be reduced to a very small extent.

The author lists the second method as feeding oxygen into the molten metal bath. He is of the opinion that this method cannot result in a sharp increase in steel smelting. However, the experience of the "Azovstal'" Plant, the Kirov Makeev Plant and a number of foreign plants indicates that feeding oxygen into the molten metal is much more efficient (as regards the furnace output and the fuel consumption) than feeding the same amount of oxygen into the flame. The intensive blowing of an open-hearth bath with oxygen is limited at the present time mainly by the low life of the refractories.

On the basis of studies made at the "Zaporozhstal'" Plant the author considers the following method to be the most promising: enrichment of the flame with oxygen up to 25% in the charging period and heating the charge, blowing the bath with a steam-oxygen mixture or a mixture of oxygen with compressed air during the melting period and the first half of the finishing period, feeding oxygen into the bath in the second half of the finishing period.

One of the faults in the analysis of the use of oxygen and the recommendations is the fact that the experience quoted is mainly that of the "Zaporozhstal'" Plant and

little account has been taken of the favorable experience in using oxygen at other plants.

The book analyzes the operation of open-hearth furnaces using compressed air and steam-oxygen mixture for blowing the bath, using cold high calorific gas to fire the furnaces with preliminary desiliconization of the iron, etc.

The author underlines the important idea that the use of oxygen to intensify steel-smelting processes can be efficient and profitable only when the organization of production is such as to exclude holdups during operation.

The use of oxygen in electrical steel-smelting production is profitable even with high oxygen cost (14 kopecks/m^3) since even with a small flow (15-25 m^3/ton) the furnace output is increased by 15-25%, and the electrical power is reduced by 20-30%. It is particularly desirable to use oxygen in the smelting of stainless steels, since better use is made of the alloyed wastes and there are reductions in the chromium and nickel losses. In 1965, therefore, all electrical furnace metal will be smelted using oxygen.

As regards the use of oxygen in converters, the author underlined the fact that in no branch of ferrous metallurgy has the use of oxygen been as efficient as in converter production. Steel smelted in a converter using oxygen contains a low content of gases and in quality it is almost as good as open-hearth steel.

Describing the favorable aspects and the essential conditions for operating 1000-ton open-hearth furnaces, in conclusion the author rejects them and recommends the construction of 75 and 100-ton oxygen converters and also 350 and 700-ton open-hearth furnaces.

For processing iron with a high phosphorus content it is recommended that near the Kerchensk, Ayatsk and Lisakovsk deposits plants be constructed with converter departments with top oxygen blast to produce high-grade steel and phosphate slags.

Analyzing new methods for producing steel using oxygen, the author recommends experimental testing under appropriate conditions. For example, he rightly considers that a 100-ton rotary furnace should be built at the "Azovstal'" Plant where high phosphorus iron is converted.

Considering the book as a whole it can be stated with certainty that it will be of considerable help to metallurgists in considering the numerous features of the intensification processes with oxygen. Naturally the author has not given a final answer to many unsolved problems, nor could he do so since in many of these problems contradictory opinions are held by scientists and engineers (intensification of the blast-furnace process with oxygen, the most efficient method for using oxygen in smelting various grades of steel, etc.). In the text there is uncertainty as to the findings of individual investigations. Nevertheless, the answers, generalizations and recommendations given will undoubtedly be useful in developing new methods in steel production.

I. N. Sushkin, Fundamentals of Heat Technology. Moscow, Metallurgizdat, 1958. 356 pages.

Reviewed by N. F. Yakovlev, A. O. Pushkevich, and S. L. Chekhol'skii.

The textbook deals with the fundamentals of technical thermodynamics and heat exchange. It considers the basic principles of thermodynamics, the gas laws, specific heat, the first and second laws of thermodynamics, the basic processes for change of state of an ideal gas, water vapor, escape of a gas and throttling, cycles of piston engines and compressors, the transfer of heat by thermal conductivity, by contact and by radiation, and also a calculation of convection heat-exchange apparatus. The book gives many worked problems and excercises. Each chapter of the book finishes with test problems.

The book is particularly concise, and clear in the layout of its material. The presentation of the material is based mainly on the level of knowledge of the readers for which it is intended, i.e., students at schools and foremen. The author also deals with basic problems which might interest students who are not specializing in power engineering, so that the textbook can also be recommended for students of technical universities.

Experience with students of the S. M. Kirov Byelorussian Timber Engineering Instutute shows that the simplicity and easy style of the book are of considerable value in a course of heat technology. As a rule, the students prefer this book to other textbooks on the subject.

When the book is revised it would be desirable to correct the faults which were found in it. For example, when presenting the second principle of thermodynamics the author introduces entropy according to the Clausius method. When dealing with properties of entropy he uses the integral $\int \frac{dq}{T}$ for a lengthy period (pp. 124-139).

Bearing in mind that the readers for which the book was intended have a poor understanding of the principles of differential and integral calculations it would have been better to either change completely the introduction of the concept of entropy (for example to assume this concept from the very beginning without any foundation) or to immediately (on page 124) designate the corresponding ratio of the value by ΔS and carry out the further analysis by means of the concept of entropy. The prolonged use of the integral $\int \frac{dq}{T}$ definitely obscures the physical meaning of the phenomenon considered.

When dealing with the basic thermodynamic processes of an ideal gas it would have been better to represent the quantity of heat, work and change in the internal energy of the gas on circular diagrams, where each value corresponds to a segment with a certain angle at the peak and with a certain shading. These diagrams, compiled for each thermodynamic process, very clearly characterize the fraction of heat used to perform work and to change the internal energy of the gas.

In the practical calculations, the students should use natural logarithms. It would therefore have been desirable to give a small table of natural logarithms in the appendix.

The section devoted to heat exchange by radiation between solids (pp. 316-320) is probably unnecessary in a textbook of this type, especially since some of the expressions are given without a derivation.

Unfortunately there are many printing errors in this textbook, this being a serious fault in an otherwise good book.

SIGNIFICANCE OF ABBREVIATIONS MOST FREQUENTLY ENCOUNTERED IN SOVIET PERIODICALS

FIAN	Phys. Inst. Acad. Sci. USSR.
GDI	Water Power Inst.
GITI	State Sci.-Tech. Press
GITTL	State Tech. and Theor. Lit. Press
GONTI	State United Sci.-Tech. Press
Gosénergoizdat	State Power Engr. Press
Goskhimizdat	State Chem. Press
GOST	All-Union State Standard
GTTI	State Tech. and Theor. Lit. Press
IL	Foreign Lit. Press
ISN (Izd. Sov. Nauk)	Soviet Science Press
Izd. AN SSSR	Acad. Sci. USSR Press
Izd. MGU	Moscow State Univ. Press
LÉIIZhT	Leningrad Power Inst. of Railroad Engineering
LÉT	Leningrad Elec. Engr. School
LÉTI	Leningrad Electrotechnical Inst.
LÉTIIZhT	Leningrad Electrical Engineering Research Inst. of Railroad Engr.
Mashgiz	State Sci.-Tech. Press for Machine Construction Lit.
MÉP	Ministry of Electrotechnical Industry
MÉS	Ministry of Electrical Power Plants
MÉSÉP	Ministry of Electrical Power Plants and the Electrical Industry
MGU	Moscow State Univ.
MKhTi	Moscow Inst. Chem. Tech.
MOPI	Moscow Regional Pedagogical Inst.
MSP	Ministry of Industrial Construction
NIIZVUKSZAPIOI	Scientific Research Inst. of Sound Recording
NIKFI	Sci. Inst. of Modern Motion Picture Photography
ONTI	United Sci.-Tech. Press
OTI	Division of Technical Information
OTN	Div. Tech. Sci.
Stroiizdat	Construction Press
TOÉ	Association of Power Engineers
TsKTI	Central Research Inst. for Boilers and Turbines
TsNIÉL	Central Scientific Research Elec. Engr. Lab.
TsNIÉL-MÉS	Central Scientific Research Elec. Engr. Lab.-Ministry of Electric Power Plants
TsVTI	Central Office of Economic Information
UF	Ural Branch
VIÉSKh	All-Union Inst. of Rural Elec. Power Stations
VNIIM	All-Union Scientific Research Inst. of Meteorology
VNIIZhDT	All-Union Scientific Research Inst. of Railroad Engineering
VTI	All-Union Thermotech. Inst.
VZÉI	All-Union Power Correspondence Inst.

Note: Abbreviations not on this list and not explained in the translation have been transliterated, no further information about their significance being available to us - Publisher.